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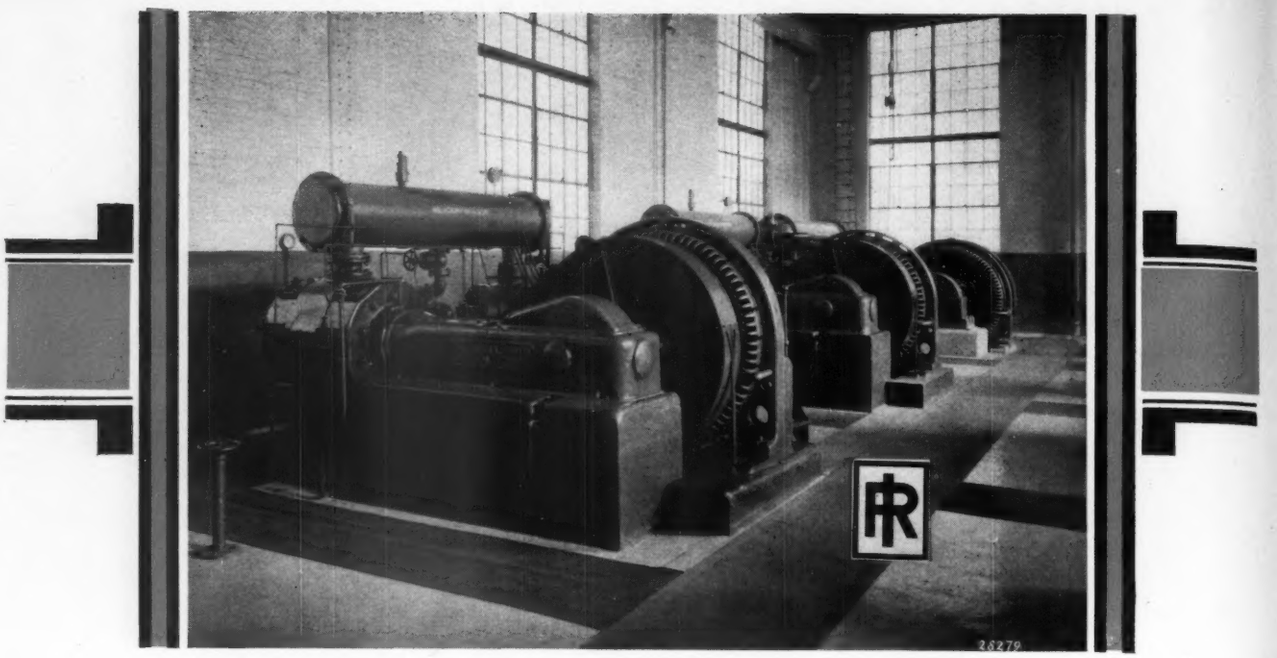

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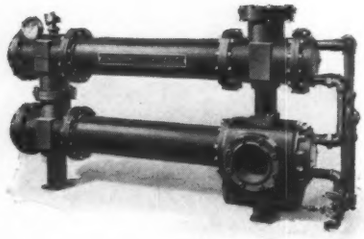

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Number 9

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A. W. ALLEN, *Editor*

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New York, March 2, 1929

Mining One of the World's Greatest Orebodies

MOLYBDENUM is a rare metal—but not at Climax, Colo. There it exists in such vast quantities, in the form of molybdenite, that the reserves of elemental molybdenum are calculated in the hundreds of millions of pounds. The problem is therefore a marketing one, with low prices necessary to enable molybdenum to compete with other iron and steel alloying compounds. Low selling prices mean low cost production, by methods which will be described in two outstanding articles soon to appear in *E. & M. J.* That on mining, describing in detail the methods and equipment used for extracting the ore, will be published next week. Milling will be discussed subsequently.

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Volume 127 — *New York, March 2, 1929* — Number 9

The Presidencies

A YEAR ago *Engineering and Mining Journal* predicted that Mr. Hoover's election to the high office of Chief Executive of the Nation was an outcome that could be doubted by no one with an appreciation of his fitness for the position and a knowledge of his professional and public service to the United States and to the world at large. Happily, those possessed with discernment and a sense of proportion were in the great majority when the votes were cast. Mr. Hoover, a former president of that society, attended the annual meeting of the A.I.M.E. in 1928 and received the Saunders gold medal. Had his new responsibilities not interfered, he would have attended the annual banquet, held last week, to receive the John Fritz medal, voted to him by all groups of the engineering professions in the United States. Honor and recognition by his confrères could go no further. The presidential inauguration is at hand, and beyond that lies what those who are privileged to know him believe will prove to be the most constructive period in the history of the United States.

The annual meeting of the Institute is alike an occasion for regret and satisfaction—regret that an honored public servant cannot hold office indefinitely, and satisfaction that he can be replaced by one equally worthy. Dr. George Otis Smith, the retiring president, has earned fresh laurels by his broad sympathies and cultured understanding, as applied to the problems of the mining industry and the work of the Institute. Mr. Frederick W. Bradley, his successor, brings to the presidency the spirit of courage and tenacity so characteristic of pioneers of the West, alloyed with an executive skill and a technical discernment that will prove of value in the conduct of the society's affairs. In this task he will have the able assistance of Secretary H. Foster Bain.

To the President of the United States and to the president of the A.I.M.E., *Engineering and Mining Journal* promises loyal support, coupled with felicitations and good wishes for successful terms of office, confident that the incumbencies of both will redound to the credit of the profession of which they are honored members.

Potash Exploration Work in Southwest Is Successful

EXPLORATION for potash by the government and private industry in the Permian of Texas and New Mexico has had notable results. No longer is the United States to be regarded as lacking in resources of this mineral, save for its occurrence in the brines of Searles Lake in California. That which has been accomplished was told by Messrs. G. R. Mansfield and W. B. Lang, of the U. S. Geological Survey, at the recent meeting of the A.I.M.E. in New York. Their paper is a milestone in the course of the nation's mineral development. A résumé was presented in the issue of Feb. 23 on page 336.

Only the existence of the potash has been demonstrated, to be sure. No production has yet been made. The thickness and analyses of certain of the beds, proved by drilling at depths ranging from about 700 to 2,000 feet, suggest the possibility of commercial exploitation. Considerable money must be spent in underground exploration and development before production is an actuality, and only a company or an individual of means can hope to carry through such a project with success.

In describing the outlook for the prospective industry, Messrs. Mansfield and Lang use words deserving of attention. "Sufficient supplies of potash salts have been demonstrated to be present in the Permian," they say, "so that, if production problems were solved, the United States could feel assured of freedom from foreign monopoly during any future national emergency, as in 1910, when existing American potash contracts were voided by German legislation, and again in 1915." Here manganese is brought to mind. How similar is the status of the two minerals in this respect! If the argument advanced by some against the further development of domestic manganese resources were sound, it would be equally applicable to potash. In that case one might logically say that the potash in Texas and New Mexico should be left in the ground as a reserve against a possible war-time need or against a peace-time emergency such as the German government created in 1910. But Messrs. Mansfield and Lang go a step further, They say: "Since, however, production from such sources cannot spring up overnight, it is highly desirable from the viewpoint of the national welfare that the problems of potash production in this field be solved without undue delay and that commercial exploitation be started if practicable." Problems there are, of course—problems of transportation and marketing, of mining and chemical engineering, including beneficiation. This is to be expected, and time will be required for their solution, just as in the case of manganese.

Two years remain of the five-year period authorized

by Congress on June 25, 1926, for the conduct and exploration for potash by the Government. The search should continue and be pressed as hard as the funds available will permit. Splendid work has been done thus far, of great importance to the United States.

Co-operative Development Successful in East Tintic District

CO-OPERATIVE ACTION on the part of two or more companies with mutual interests is not an unusual proceeding in the mining industry. Water and power supply, underground ventilation and fire prevention—these involve problems of mine operation that are frequently solved on a co-operative basis by several companies controlling contiguous mines. Seldom, however, is the exploration and development of new territory so accomplished. This fact makes particularly noteworthy the recent operations in the East Tintic district of Utah that were performed jointly and with such outstanding success by North Lily, Tintic Standard and Chief Consolidated. In this instance, not only was geologic and other technical knowledge pooled, but underground operations for mutual benefit were undertaken by these companies. This was especially exemplified in the driving of the 2,600-ft. drift from the 700 level of the Tintic Standard mine to the North Lily property. The drift in reaching its objective penetrated holdings of each of the three companies; it was driven by mining crews of the Tintic Standard at the expense of North Lily; and later, when the orebody of the North Lily was reached, the ore was trammed through the drift and hoisted at the Tintic Standard shaft. Subsequently, development of the North Lily disclosed the presence of ore in the adjoining Eureka Lilly property of Chief Consolidated. A shaft, situated so as to serve efficiently both the North Lily and Eureka Lilly mines, was sunk on the North Lily property, and, by virtue of it and the utilization of the underground workings of the North Lily, the Eureka Lilly was also expeditiously and economically developed into a producing mine.

Besides attracting considerable attention to the possibilities of the East Tintic district that will without question react to the benefit of the mining industry in the Salt Lake valley, the three aforesaid companies, as a result of their co-operative efforts, evolved an unusually successful method of achievement that undoubtedly could be adopted advantageously by companies in other districts.

Announcing One of Aviation's Secrets

MINING engineers are intensely interested in the airplane as an important aid in the solution of transportation problems peculiar to their industry. They are familiar with the great amount of time saved in prospecting inaccessible regions in Africa, Canada, and Central America, as has been described in some detail in these columns. Early development of the Rouyn area, in Quebec, in the days when the use of canoe or dog sled was necessary to reach the camp, was greatly facilitated by carrying in men and supplies by airplane, and such commercial use of air transportation has been a feature of the development of Ontario and Manitoba mining districts as well. Products of inaccessible mines have been taken out to civilization by the same means.

So it has been natural that many readers, in exchanging personal confidences, have asked why McGraw-Hill does not publish an aviation magazine. They are anxious to have more explicit information on proper equipment and its operation, published for engineers under McGraw-Hill standards, than *E. & M. J.* or its sister publications have had the space to give them. The want is now supplied. *Aviation,* the oldest aeronautical magazine in the country, joins the family this month, and will give that service to mining as well as to other engineers that they have a right to expect from McGraw-Hill.

State Encouragement of Mining in South Australia

A RECENT government report from Adelaide, South Australia, issued by the Department of Mines and submitted by Mr. L. Keith Ward, director, contains details of payments in the form of government subsidies to prospectors, small-mine owners, and operating companies, to encourage the development of the mineral industries of the state. A debit balance of about £50,000 is shown, but the report gives figures and data indicating that benefits to the state have accrued as a result of the help given.

For purposes of record and possible emulation elsewhere, the legislative steps taken by South Australia in this connection are worth recalling: The Mining Act of 1893 gave the Minister of Mines the power to grant rewards to prospectors and discoverers, and subsidies to persons engaged in deep sinking and mining, and to loan boring plant. The rewards for discovery vary from £100 to £1,000, the amount being determined in proportion to the total number of men employed on the property six months after such discovery. Subsidies are granted to individuals or companies engaged in deep mining work, on condition that the applicant expends at least an equal amount to that provided by the government, the total for any one grant not being in excess of £1,000. The obligation constitutes a debt to the Crown, to be repaid by a lien on 50 per cent of the net profits, if and when made, resulting from such development. A bill of sale to the Minister of Mines, conveying all chattels, is a preliminary to the granting of any subsidy.

Drill and boring machines are loaned by the government on the recommendation of the state geologist or the state inspector of mines, and are operated by a staff appointed by the Minister. The applicant pays half the cost of boring, and also meets other less important charges. The sites for the holes are determined by agreement between the applicant and the government officials. State expenditure of this character constitutes a debt on the property, obligation for which is assumed by the applicant, to be repaid from future net profit.

How far such a plan would be practicable in other countries is a subject open for discussion. South Australia has made a plucky attempt to develop a mining industry, and the assistance given by the government has helped at least in forming an estimate of potentialities. The number of individuals and companies to which

subsidies have been paid would appear to provide ample justification for the inception and operation of the plan. Output returns from South Australia in recent years show a disheartening decline in respect to gold, silver, and other non-ferrous metals; but the state has the satisfaction of knowing that every opportunity has been given to encourage the industry by reward and assistance. Elsewhere, a similar subsidy plan might well have shown most favorable results, and data on the operation of state subsidies in other countries would doubtless support this assumption.

Chilean Nitrate Price Must Be Reduced

THE CHEMICAL INDUSTRY, interested in the manufacture of byproduct nitrogen compounds and synthetic substitutes for natural nitrate, is becoming concerned at the increased output of the Chilean product, which is said to have reached 3½ million short tons in 1928; with world stocks, on December 31, of 2,350,000 tons. A substantial lowering in price of the natural product is therefore probable, and this prospect prompts anxiety among its competitors. Arguments are advanced that the world cannot absorb the present Chilean output, but the assumption ignores its prospects for success in a competitive struggle for world markets.

Warnings of an inevitable trend have fallen on deaf ears. Ever since Sir William Crookes, in 1898, predicted world starvation because of an alleged impending failure of the Chilean nitrate-mining industry, by reason of exhaustion of the natural deposits, a complacent propaganda has been in evidence which assumed that the nitrogen market could be captured by the application of science and engineering to the problems of fixing the nitrogen in the air, by synthetic processes, and byproduct development. Commendable progress has been made in all these directions, but rarely has the least attention been paid to plain statements of fact as to the exent of the Chilean deposits and to evidence indicating the opportunity for drastic reduction in the cost to the ultimate consumer—by scaling or abolishing the export tax, and by the application of engineering experience and skill in the most backward large-scale industry of the world. The chemical industries have failed to investigate the potentialities of Chile as a stable source for a large proportion of the world's nitrogen requirements, or to accept the contention advanced that the region offers exceptional opportunities for large-scale output and low-cost production—demonstrated conclusively in regard to copper, after a long period of skepticism. If the synthetic and byproduct industries had paused to note the handwriting on the wall, and had extended the courtesy of an early invitation to the Chilean producers to join in the deliberations on board the "Lutzow" in 1927, some arrangement as to world markets might have been evolved, of mutual advantage.

The impending acute competition between natural and synthetic nitrogen products must be to the ultimate advanage of the Chilean nitrate-mining industry. It will bring into sharp focus the need for economy and efficiency in mining and treating the raw material. Scientific inquiry and research in accord with the dictates of common sense must be encouraged; but, first of all, need is apparent for the frank publication of engineering opinion and data.

Employment Problems in Great Britain and South Africa

THE MENACE of permanent unemployment for 500,000 workers in the basic industries of Great Britain looms large on the horizon. In its haste to get nowhere in particular, the economic evolution of the world seems to have passed by these hapless people and left them stranded on the shore, with no new boats handy for launching on the industrial sea, according to Mr. Henry Noel Brailsford, distinguished English writer and economist, who recently visited the United States.

Particularly acute is the situation in the coal fields. In South Wales and Northumberland the substitution of oil for coal as steamship fuel has left its mark. Careful investigation has disclosed that, no matter what steps are taken to foster coal consumption, probably 250,000 miners will never again enter a coal mine. So important and so imminent is this question that the politicians have been unable to avoid it. All three of the major English political organizations, now preparing for the general election in June, have taken stands on the matter. Most of the suggested remedies involve the transference of miners into other vocational fields. After 150 years of growing industrialism, started by the invention of the steam engine, Great Britain is once more having the economic potentialities in the cultivation of her green fields pointed out to her, though the maximum expansion in this direction, of course, can hardly be expected to exert the dominant influence in her economic life.

Transition from miner to farmer involves considerable time for its accomplishment, but, no matter how painful or long-drawn the step may be, the exigencies of a large and growing population demand that it be taken. Lacking in volume the export trade that was previously its chief support, England is probably overpopulated, Mr. Brailsford observes, and little room for the surplus is available in the dominions.

Dispatches to *Engineering and Mining Journal* from Johannesburg for several years have emphasized the shortage of labor on the Witwatersrand, the world's greatest gold field. Already the properties there employ 20,000 white miners, and it would seem that opportunity exists for adding to that number as the colored labor becomes more and more scarce, and recruiting campaigns are spread over greater areas. The Portuguese authorities look with disfavor on having the supply imported from Mozambique, and an agreement now in effect will gradually diminish the number available from that source each year.

The white miner, being more accustomed to the use of machinery, more intelligent, and less prone to indolence, is far more productive than his colored co-worker, even under the trying conditions which prevail in the depths of the Rand mines. Importation of, say, 10,000 additional miners from the distressed coal districts in Great Britain should serve four ends. It would guarantee a continuation of the tremendous gold output of the Rand, a question of importance to the banking and credit systems of the world. Increased profits would accrue by a decrease in labor costs. The Transvaal would become a training ground for British miners that will be needed in the development within the next few years of the immense Rhodesian copper deposits recently discovered. And, finally, it would help to alleviate, even though only in small measure, an unhappy situation in Great Britain.

Filling Stopes With Mill T

at Minas de M

By GEORGE L. RICHERT
Minas de Matahambre, Cuba

MINAS DE MATAHAMBRE is situated on the north coast of Cuba, in the province of Pinar del Rio, approximately 150 miles west of Havana. The mine, which is the only producer of copper in Cuba, has been worked by various operators for the last fifteen years. In 1921 the property became affiliated with the American Metal Company, Ltd., and it has been operated by that company since that time under the direction of D. D. Homer, general manager.

The orebodies in the Matahambre mine occur as large irregular pipes, usually of lenticular cross-section, of primary chalcopyrite locally associated with quartz and pyrite. The main mineralized zone trends N. 30 deg. E. and dips 42 to 45 deg. northwest. In this mine, the country rock is a uniform series of alternating shale and quartzite beds.

The mine, operated by one vertical shaft of three compartments, is producing 30,000 tons of ore per month. Its levels are spaced 100 to 135 ft. apart, and the ore is mined by the flat-back cut-and-fill system. Stopes are silled out 13 ft. above the levels. The hanging wall is usually of shale and weak, whereas the footwall is of quartzite and gives no trouble. Cuts are from 8 to 12 ft. high, and stopes are filled as soon as possible after a cut has been taken.

Filling stopes with classified mill tailing in place of gloryholed surface waste was started in the latter part of 1925. With the exception of a few short periods soon after the system was installed, the practice has been in continuous operation since that time. The classified mill tailing which is put into the mine is known locally as "sand fill," and all operations and apparatus connected with "sand filling" are part of the sand-fill system.

Placing of tailing in the mine as fill consists essentially of the following operations, each of which will be described separately:

1. Pumping mill tailings through a 6-in. iron pipe from the mill to a Dorr bowl classifier.
2. Removing slimes at the classifier, adding water, and discharging "sand" into the pipe for distribution in the mine.
3. Running "sand" through the pipe or hose from the surface to the stopes.
4. Wrapping the cribbed ore passes and manways in the stopes with burlap.

1. Roughly 80 per cent of the mill feed is tailing, but this percentage varies with the ratio of concentration. Although all the mill tailing is available for classification and stope filling, only 50 to 80 per cent is sent to the bowl classifier. This may be due to the shutdown of the classifier when the pipe has broken in the mine, to no stopes being ready for filling, or to other causes. The tailing not pumped to the classifier is sent direct to the pond.

A sample screen analysis of the tailing as discharged from the mill is given in Table I.

Screen analysis of the tailing varies from day to day as the amounts of quartzite and shale in the mill feed vary. Mill tailing, averaging 30 per cent solids by weight, is discharged to a 6-in. model C Wilfley centrifugal sand pump operating at 950 r.p.m. The pump is

Tailing

Matahambre, in Pinar del Rio, Cuba

driven by a 50-hp. belt-connected G.E. induction motor (220 volts, 3-phase, 60 cycles). The tailings are pumped through a 6-in. pipe a distance of 850 ft. against a head of 45 ft.

Desliming the Tailing

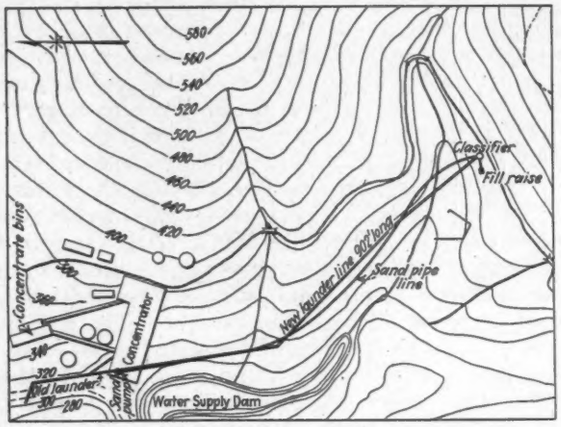
2. From the pump line the tailing is discharged into the bowl classifier (Type D.S.D.B., 6x26 ft. 8 in. by 16 ft. bowl). Of the total tailing pumped to the classifier an average of 48 per cent of the solids is discharged into the mine fill pipe and 52 per cent, as slime overflow, is sent to the pond. These percentages vary, the amount entering the mine running as high as 65 per cent and at times as low as 30 per cent. This fluctuation is also due to changes in the amount of shale and quartzite in the ore milled. Table II shows an average screen analysis of the classifier discharge, which, averaging 80 per cent solids by weight, is discharged at the rate of 15.6 tons per hour of classifier operation. To it is added a maximum of 18 gal. of water per minute. This water is added by means of a ½-in. spray pipe with 32 openings and discharging directly over the mine fill pipe. This gives a total of 1,830 gal. of water per hour, including the water in the classifier discharge, which goes with 12.5 tons of sand per hour into the mine. In addition, after the classifier has been shut down, water is run into the fill pipe to flush it out and keep the sand from settling in the curves and flat stretches. Sand fill data for September, 1928, are given in Table III.

3. To date, the running of sand fill through pipe or hose from the classifier on the surface to the stopes in the mine has passed through three experimental stages and will soon be on the fourth and it is hoped the best and last stage. During the first stage the mill tailing was put through a small cone classifier and the sand run by gravity through a 4-in. iron pipe into the mine. This was not satisfactory, as the sand plugged up in the 4-in. pipe, owing to lack of velocity. Much time was spent finding the plugged pipe and cleaning it out after it was found. In the second experimental stage, after a 16-ft. bowl classifier had replaced the cone classifier, an ordinary 2-in. iron pipe was used to run the sand into the mine. This pipe carried the sand satisfactorily, but was good for the passage of only a thousand tons, or less, at the bends in the line where the wear was the greatest. It was replaced by 2-in. extra heavy pipe with plain ends, the lengths of which were joined together with Dresser couplings. This heavier pipe lasted much longer than the other, but filling costs were still high because of the extra labor necessary to change the pipe and to clean up "spills" when the pipe wore through. However, even with high fill costs, use of the sand was profitable to the mine because of the amount of fill available, the ease of handling in stopes, and also because the fill did not spread and because a comparatively short time was required to fill a stope.

In the third stage, special four-ply rubber hose, having a rubber lining ¼ in. thick and an inside diameter of 2 in. was used from the surface, through the raises, to the 1,100-ft. level. This hose was an improvement over the iron pipe, as it carried 25,000 to 30,000 tons of fill before failing. However, it kinked at the bends, so that it was necessary to place a split pipe sleeve, bent to the desired curve, at all curves in the line. The couplings consist of a rubber-lined nipple, inserted in the ends of each piece of hose with a Victaulic coupling for each length. The rubber hose failed first just behind the coupling. This was probably caused by the offset in the inner lining between the hose and the nipple. This offset retarded the flow of the sand and built up a high pressure at this point. To remedy this fault and lengthen the life of the hose, a six-ply rubber hose having a ¼-in. lining and a 2-in. inside diameter was installed. This has three heavy iron clamps where the hose fits over the nipple in place of the two lighter iron clamps used on the four-ply hose. Life of the hose is unknown.

At the time the 2-in. iron pipe was changed to 2-in. extra-heavy iron pipe, 50 ft. of 3-in. iron pipe, rubber lined, was put into the line for a trial. This pipe had ¼-in. walls and a ¼-in. rubber lining, the inside diameter thus being 2½ in. This section of pipe was examined whenever opportunity afforded. After it had been in service over one year and had handled around 80,000 tons of fill, a piece was brought to the surface for better examination. A close inspection revealed no apparent wear on the rubber lining. The iron pipe had rusted on the outside, but not

enough to weaken it. Sections of the pipe are 10 ft. in length and are joined by means of rubber-faced flanged couplings. The rubber on the face of the couplings allows the line of the pipe to be changed about 20 deg. without bending the pipe. This is accomplished by tightening the flange bolts on one side more than those on the other. While on the surface, a piece of this rubber-lined pipe was bent cold 90 deg. The center of the bend was cut, and an examination showed that the



Surface map showing the sand-fill line between concentrator and classifier

rubber did not wrinkle or come loose from the pipe. This will permit bending the pipe to any desired curve. Two thousand feet of this pipe has been ordered to replace the rubber hose now in service.

To date, 95 per cent of all trouble experienced with pipe and hose has been in the raises between the classifiers and the 1,100 level. This is caused by the high velocity of the fill in this line and by the curves and bends made necessary in passing from one raise to another and bringing the pipe out on a level. At present there is about 7,000 ft. of sand-fill hose and pipe in the mine. The 2,000 ft. of rubber-lined pipe will be installed as a main line from the surface through the raises to the 1,100 level and along the latter. The rubber hose and extra-heavy iron pipe now in service will be used in the branch lines from the main line to the stopes.

Wrapping Ore Passes and Manways With Burlap

4. As all ore passes and manways into the stopes are built up of 6-in. round cribbing with a 4-in. tongue, it is necessary to wrap the cribbed ore pass or manway with 10-oz. burlap to prevent the sand washing out. This method worked satisfactorily until the stope had been filled to a height of 60 or 70 ft. above the level. As most of the water from each filling settles directly to the first sill door and then seeps out between the cribbing to the drift below, the burlap on the lower part of the manways and ore passes rotted out after the stope had been filled a number of times. To eliminate the spills

Table I—Screen Analysis of Tailing as Discharged from Mill

	Mesh	Direct, Per Cent	Cumulative, Per Cent
Plus	48	20	20
Plus	65	10	30
Plus	100	8	38
Plus	200	11	49
Minus	200	51	51
		100	100

Table II—Average Screen Analysis of Classifier Discharge

	Mesh	Direct, Per Cent	Cumulative, Per Cen
Plus	48	40	40
Plus	65	20	60
Plus	100	22.5	82.5
Plus	200	9.5	92.0
Minus	200	8.0	8.0
		100.0	100.0

caused by the burlap giving away it was decided to line the inside of all stope ore passes and manways with 2-in. plank. This was necessary to protect the cribbing in the ore passes, regardless of the sand fill, as some trouble had been experienced with the cribbing cutting out before the stope had been taken up to the level above. Burlap is also used in some stopes along the fractured shale hanging wall. Whether or not the use of burlap along the hanging wall is profitable or does any real good is doubtful.

Tonnage and Costs

From Jan. 1, 1928, to Oct. 1, 1928, a total of 63,354 tons of classified mill tailings was put into the mine for stope filling. The average cost was 35.3c. per ton of sand fill, divided as follows: Labor, 15.6c.; power, 1.1c.; supplies, 18.6c.—a total of 35.3c. The labor cost includes all labor connected with sand filling, pumping the classifier, and also the two men on each shift engaged in changing or placing pipe and handling the discharge in stopes, together with the labor required to clean up spills.

The cost of supplies is divided as follows:

Pipe	11.0c. per ton of fill placed
Miscellaneous	2.2c. per ton of fill placed
Burlap	5.4c. per ton of fill placed

Table III—Sand Fill Data for September, 1928

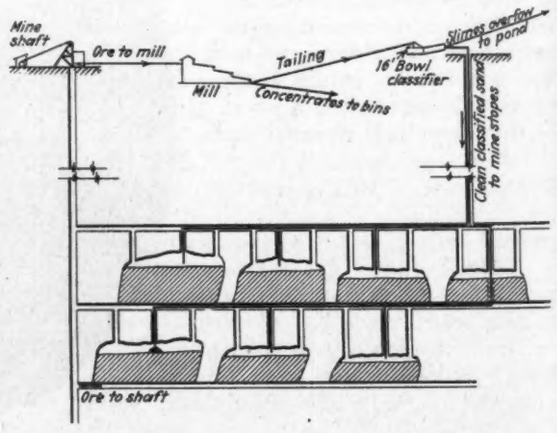
Total tons of mill tailings	24,018
Per cent of total to classifier	55.5
Total tons to classifier	13,400
Per cent of total tailing into classifier discharged as mine fill	46.5
Total tons of sand to mine	6,240
Tons of solids, including classifier overflow and tailings pumped direct to the tailing pond	17,778
Per cent of total mill tail placed in the mine as fill	26

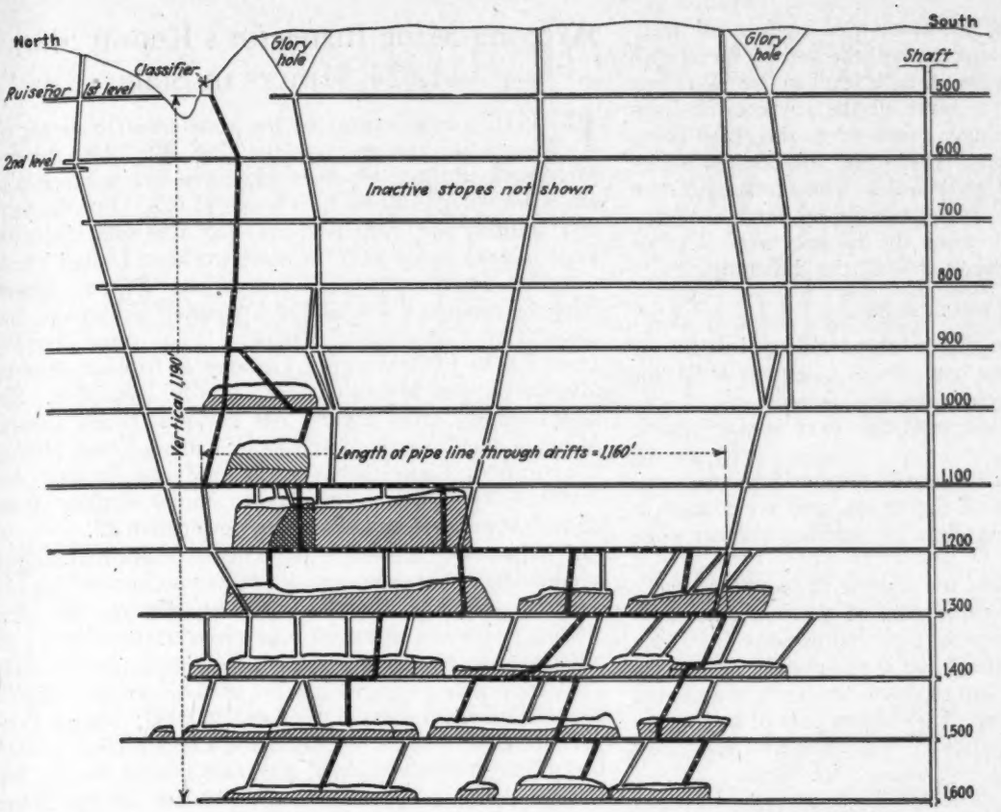
Individual item, costs not including installation, are:

10-oz. burlap	11¼c. per yd. 3 ft. wide 30yd rls.
Extra heavy pipe	30c. per ft. 10 ft. lengths
4-ply special 2 in. rubber hose	$1.60 per ft. 40 ft. lengths
4-ply special 2 in. rubber hose	$1.68 per ft. 40 ft. lengths
Rubber lined pipe, 3 in. inside diameter	$3.00 per ft. 10 ft. lengths

With the installation of 2,000 ft. of the 3-in. rubber-lined pipe, a sample of which has apparently shown no wear of the lining after being in use one year, and on

Diagrammatic sketch showing the Matahambre system of filling stopes





Longitudinal section of Matahambre mine, showing "sand-fill" system in use. The heavy line shows the distribution pipe line.

the basis of a conservative estimate of its life of service at one and one-half years, the amount of fill placed in the mine for this period remaining the same as in the past, the cost of pipe for handling an estimated 126,526 tons of fill in one and one-half years would be 0.0475c. per ton. The labor cost with the 3-in. pipe in operation should be cut at least in half. With an estimated additional cost of 1¼c. per ton for replacing feeder pipe lines into the stopes, the total cost for pipe should be around 6c. per ton of sand placed in the mine.

In the near future it will be possible to run a raise from the mine connecting with the surface at the bottom of the mill. The classifier will then be moved to the mill, the sand pump eliminated, and all the sand fill handled by gravity.

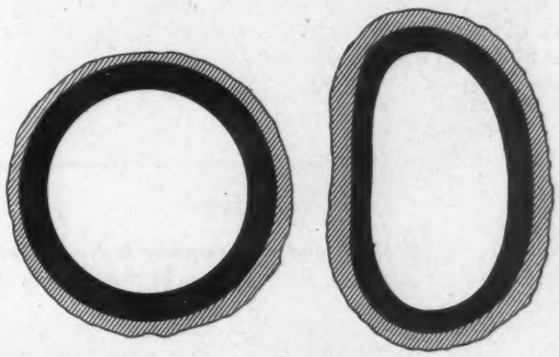
As the larger part of the miscellaneous cost of 2.2c. per ton is made up of sand pump costs, the miscellaneous cost should be cut to ½c. per ton. This arrangement with the sand pump eliminated should also cut the power cost from 1.1 per ton to 0.5c. per ton.

With the 3-in. rubber-lined pipe in place and the classifier at the mill as planned, estimated sand fill costs would be approximately as follows:

	Cents	Supplies	Cents
Labor	7.8	Pipe	6.0
Power	0.5	Miscellaneous	0.5
Supplies	11.9	Burlap	5.4
	20.2		11.9

In general, several interesting facts have been determined. It has been found that 100 ft. of head in the sand fill pipe will force the sand 400 ft. along a drift. The use of threaded or plain unlined flanged couplings on pipe has not proved satisfactory. Large stopes can be filled in any desired part, ends or center, by building small sand dams with shovels and placing the discharge pipe behind the dams. With the use of classified tailings, from which the slime has been removed, it is found that in 24 hours practically all the water has settled out and passed into the drift below. The sand fill enters all cracks and fissures along both walls, forming a better pillar than could be obtained with the use of rock fill.

Use of sand fill has cut down the number of fill raises necessary in the larger stopes. Previously it was necessary to have one every 80 ft. With the sand fill one



Photograph of section of 3½-in. iron pipe, with walls ¼ in. thick and having a quarter-inch rubber lining. The inside diameter is 2½ in. This pipe has handled about 85,000 tons of sand fill and has been in service more than one year with no appreciable sign of wear on the rubber lining. The bent piece is a section cut from the center of a 90-deg. turn put into the pipe after it was taken out of the mine, showing that bending does not loosen or distort the rubber lining. The pipe is apparently less than ¼ in. thick in photograph, owing to rusting from the outside.

every 200 to 300 ft. is ample, as the sand can be piped to any part of the stope.

In 1924, before any mill tailing had been put into the mine as fill, 112,805 tons of surface fill was placed in the mine at a cost of 55c. per ton of fill. The present cost of 35.3c. shows a saving of 19.7c. per ton of fill.

Before installing the sand-fill system, production from

the mine was limited by the amount of surface fill available. As the mine became deeper, the use of surface fill necessitated long crosscuts on each level to the fill raises. It was also necessary to tram all the surface fill from the central raises to branch raises or to the stope being filled. During the rainy season the fill became sticky and was extremely hard to handle. The surface fill then had to be spread in the stopes, usually by hand, as scrapers were unsatisfactory when the fill was wet. Use of mill tailing as fill has eliminated all the difficulties.

Conclusion

Classified mill tailings for stope filling instead of glory-hole surface waste has proven a success at Minas de Matahambre. The outstanding advantages of the classified mill tailings, or sand fill, over surface waste filling are:

1. Ease of handling: There is no mucking, no tramming, no spreading of fill in stopes, and no change in handling conditions regardless of surface weather conditions.
2. Sand fill is available for a stope in one part of the mine and for one in another part of the mine the same day, if desired. A change in pipe connections from one branch line to another is all that is required.
3. Fewer fill raises from stopes to the levels are needed with sand fill, as it can be piped to any part of a stope.
4. Sand fill forms a hard, even floor in the stopes, making for less dilution of the ore with waste.

From Jan. 1, 1928, to Oct. 1, 1928, a total of 63,354 tons of classified mill tailing has been put into the mine for stope filling. The average cost was 35.3c. per ton of sand fill.

With the installation of 3-in. rubber-lined pipe to replace the rubber hose now in service, and the moving of the classifier to the mill as planned, estimated fill costs per ton of sand will be 20.2c.

Mine production is no longer limited or held up by the lack of available stope filling, for, within certain limits, the more ore mined, the more tailings are available for stope filling.

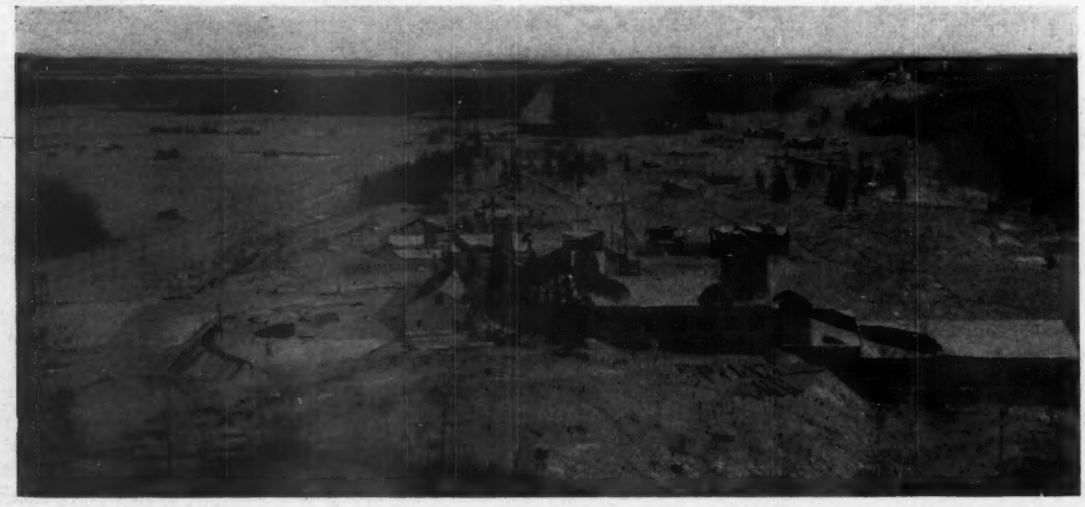
Arizona Mine Inspector's Report Shows 11,624 Miners in State

IN THE annual report of the state mine inspector of Arizona for the year ending Nov. 30, 1928, the approximate number of men employed on surface and underground at Arizona mines was 11,624. For the year 29 fatalities are reported and 555 non-fatal injuries. Four mines employ 1,000 or more workers, United Verde Copper; Phelps Dodge Corporation, Copper Queen Branch; Nevada Consolidated Copper, Ray Branch; and Inspiration Consolidated Copper. Four mines employ from 500 to 1,000 workers, Calumet & Arizona Mining, Magma Copper, Miami Copper, and Old Dominion. Six mines employ from 100 to 500 workers, Verde Central Mines, United Verde Extension, Shattuck-Denn Mining Corporation, Eagle-Picher Lead, and the Arizona Asbestos Corporation. Twenty-one mines employ from 25 to 100 workers and 88 employ fewer than 25.

Of the active mines, 49 have made or are making ore production; 45 are developing; 16 are non-producing; 11 are not shipping; one is exploring and one is shaft sinking. The classification is as given in the report.

Following are some of the more important monthly ore-production tonnages listed "at the last inspection": Inspiration Consolidated Copper, 360,000; Miami Copper, 360,000; Nevada Consolidated Copper (Ray), 275,000; United Verde Copper, 155,000; Phelps Dodge Corporation, Copper Queen Branch, 145,000; Phelps Dodge Corporation, Morenci Branch, 130,000; Calumet & Arizona Mining (Campbell), 40,000; Old Dominion, 27,000; United Verde Extension Mining, 20,000; Magma Copper, 20,000; Eagle-Picher Lead (Montana), 6,500; Alaska Commercial Mining, 5,000; Christmas Copper, 3,000; Shattuck-Denn Corporation, 2,775; Phelps Dodge Corporation lessees, Copper Queen Branch, 3,250; lessees, Morenci Branch, 2,200; Tonopah Belmont Development, 1,200. The remaining 32 companies either did not report production at the last mine inspection or produced less than 1,000 tons per month.

Mill and surface plant at No. 1 shaft of Errington mine, in the Sudbury district. In the distance at the right is No. 2 shaft.



Application of the *Petrographic Microscope* To Research in Ore-Finding Geology

PART I

By NORMAN SMITH
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THE mining industry is beginning to recognize the value of the microscope, especially that of the petrographic microscope, which is becoming known as a practical instrument. The nature of its operation, its range of usefulness, and the results that can be expected from it, have not, however, always been fully understood. This article will consider these points, and suggestions will be presented as to where better correlation of the instrument with field methods can be made.

For petrographic study, rocks are cut and ground to slices 0.03 mm. thick (0.001 in., or much like the thinnest tin foil). Friable samples are soaked in a cement before grinding, so that none of the original constituents are lost during preparation. In such thin slices all of the common minerals are translucent, light passing through the slice illuminating all the minerals and their relations to their neighbors. The slice resembles a lantern slide, the negative of a photograph, or an X-ray photograph. Thus, literally, the petrographer "sees through the ground." To carry his vision through any considerable thickness of rock, however, he must mix geologic intelligence with observations made through the microscope. The rock slice is really more satisfactory than an X-ray photograph, which only distinguishes bone from flesh. To be really comparable to a rock slice the X-ray would also have to outline veins, arteries, nerves, and muscles. Each component of a rock, no matter how small, stands out distinctly, as do all the inter-relationships of the components.

In the photomicrograph shown in Fig. 1 the thin slice has been magnified only 38 diameters. Three things, not even suspected by examination with the unaided eye, however, are immediately obvious: the feldspar has been changed; the change was produced by ore solutions; and the change is widespread. The black area is either glass or finely crystalline; in the latter case its mineral and chemical composition can be determined by raising the magnification to 2,300 diameters.

Nearly all minerals are crystalline, which means their atoms and molecules are perfectly aligned according to one of many (230) definite orderly patterns. Light passing through such crystalline, translucent substances is distorted, rearranged, refracted, and variously affected by the mineral. The effect crystals have on light, especially on polarized light, has been thoroughly studied. All of the common rock-forming minerals have been tabulated[1] according to their reaction to this specially devised type of light. Thus, by reference to tables, the exact chemical composition of many minerals, and the approximate composition of nearly all, can be fixed by merely observing them in polarized light. Such determinations are possible on particles only 0.03 mm. in diameter, and, under favorable conditions, a particle but

From "Mineral Deposits," by W. Lindgren

Fig. 1—Adularia (ad) replacing soda-lime feldspar (An) in andesite from Tonopah, Nev.
After J. E. Spurr, U. S. Geological Survey.

0.007 mm. in diameter can be handled. Work on these small particles is made possible by modern optical glass which is perfected to magnify 2,300 times. Inasmuch as many minerals contain as high as eight or nine chemical elements, it is easy to understand why an analytical chemist would welcome suggestions from the petrographer, and, in some instances, why petrography can thoroughly take the place of chemistry. When question arises as to paramorphs, pseudomorphs, or polymorphs, petrographic data will be found far more valuable than the chemical. Thus, chalcedony, vein quartz, and quartzite commonly occur in the same sample; they are all chemically identical, but are easily distinguished by textural characters seen in a thin slice.

Petrography is done indoors. The worker sits in

[1] "The Microscopic Determination of the Nonopaque Minerals," by Esper S. Larsen. U. S. Geologic Survey, 1921.

one place, and usually appears to be having a monotonous experience. He often is. He must work with a research attitude because of the patience necessary for accumulating facts and for interpreting observations correctly. To inquire into the position geologic research holds in the mining industry is thus both reasonable and desirable.

Is Applied Geologic Research Necessary?

Research takes time and requires planning. Should the mining industry, therefore, for the present, remain content with rule-of-thumb methods for prospecting, or can it develop a geology soundly based on science that will be applicable to its purposes? Varying amounts of elementary geology are being used constantly on practical problems. It seems better to ask: how much geology is necessary practically? As long as the desire to find mines exists and they become increasingly difficult to find, a larger amount of research will become practical. Wherever the examining engineer has not a sound answer to all of the following three questions, research is necessary in proportion to the amount of money staked on his report: Where did the ore come from? On what paths did it travel? Why was it dropped where we find it? Let us imagine a camp where all of these questions are open and subject to serious controversy between highly competent geologists. Under such conditions, can research that attempts to answer these questions be practical? Below, a procedure will be outlined that covers in from one to four months the whole area of districts the size of Hedley, B. C., or Tintic, Utah. Our three questions are answered in say two months, and, after four months, enough selected areas have been satisfactorily studied to justify extensive plans for definite development.

Is Ore-Finding Research Possible?

Can we develop a geology soundly based on science and applicable to ore finding? It does not seem so much a question of developing a new geology. Rather, is there a geology already developed that has not been applied, and can we apply it? As long ago as 1905, Emmons was referred to[2] for the statement that every conceivable hypothesis for the origin of any given deposit had already been presented. Ever since that culmination in the method of multiple hypotheses, the weeding-out process has been rapid and sure. In some instances the applied worker will find this, his problem, made easy for him by the fact that probably every conceivable hypothesis has also been proposed for the origin of ore deposits in general. He has only, broadly speaking, to make the deposit fit the right pigeon hole. To use George Otis Smith's term, if he is a "byproduct man" he will find a wealth of literature only waiting reinterpretation for practical use. When he is capable of interpreting this in the light of recent advances in geology and allied sciences, and of picking out material pertinent to his problem, he has often little original work to do.

Reference to literature may show that an answer already exists which could not be noticeably changed by a short period of research. On other problems it is possible to decide at once that no practical answer can be expected within a reasonable period. The importance of this class of subjects is realized if the work is to be kept within the bounds of appiied research. Often, out of several hypotheses, one may easily be adhered to with confidence after a short period of original work. Most of the problems facing a prospector fall in this class.

[2] *Economic Geology*, Vol. I, pp. 1-11.

For developing a procedure which will answer these questions, a fruitful comparison can be made between applied research, so often successful in milling or metallurgy, and the lack of such research in geology. The millman or the metallurgist can experimentally reproduce on a small scale the exact conditions to be met later in actual practice. He may, in his efforts to improve them, even manipulate the processes directly in daily operation. For a geologist to handle his material in either of these ways is impossible. The attack on a geologic problem cannot be so direct. A higher degree of complexity and a uniqueness are involved in any geologic problem that demands the element of contemplation, and a continual necessity prevails for interpreting correctly the details of observations. Good geologic theory may always continue to be only an approximation, especially in the application of general theory to specific occurrences. This group of limitations under which a geologist works may be summed up in the term *philosophic element*. How to master this element will be one of the main considerations throughout this article. The method of geologic research recommended will cut down the element of doubt in approximations by increasing the number of pertinent facts. Use of the petrographic microscope will be found to fit the nature of the method very well, and, for practical purposes it will bring under control all phases of the philosophic element.

Methods of Geologic Research

Only two types of research will be considered here. One can be called the inductive or empirical, the other experimental or laboratory. The former will be taken as that lending itself best to the purposes of applied research. The latter is but one of several other types of research, and is discussed here only because it shows so well, by contrast, the value of the inductive method.

In the laboratory a worker surrounds himself with retorts, vials, reagents, and test tubes. He cannot duplicate the complexity of nature nor the element of time. The high temperatures and high pressures produced in laboratories may be greater, equal to, or less than those involved in any specific natural process. When his work is done, the experimenter is forced to *infer* what would have happened if he had been able to reproduce natural conditions. His laboratory products have been known to resemble natural products exactly, but the temperature, pressure, time, concentration of solutions—in fact, everything employed—has not been the same as that used by nature in making her product. At its best, experimental research can only be suggestive, and of value in stimulating thought and discussion. When in its own limited field it follows an inductive plan, its results are too limted in their significance. After many years' work by many investigators, the results have sometimes been summed up so as to broadly effect geologic theory. Then it has remained necessary to adapt them to local prospecting problems. Essentially they lack that note of finality so necessary in applied research.

The Method Recommended

Using the empirical method, a worker makes Nature his laboratory. He may bring samples of her products into a laboratory for more minute examination. The facts in the field are thoroughly examined with the microscope and the unaided eye. Copious reference may be made to descriptive work done by others in the same spirit. After an exhaustively critical analysis of his

material, the empirical worker may even fit into his conclusions one or two results of experimental workers. Without either of such references to the work of others, the empirical method can give quite definite conclusions when applied to a mining district which, according to theories of ore deposition, covers a genetic province. Combinations of facts will be found around orebodies. Repetition elsewhere of such combinations in unprospected ground can only mean that ore exists. The empirical method reduces the philosophic element by increasing the number of facts related to local ore occurrence. In this sense geologic science is developed more than is essential to take a major part in deliberations on any exploration program. Petrography is a perfected tool, a true means to our ends in increasing greatly the number of available facts on which to base conclusions. Factors essential to a successful program of applied petrography can only be arbitrarily separated from one another; they are: the petrographer, the subject for investigation, collection of samples, and correlation of field and microscopic data. They will weave in and out of the problem of developing a good empirical method.

The Petrographer

In common with most complicated instruments, the microscope is only as valuable as the man using it. Applied petrography is rather a novelty, and the supply of good workers is not large. For that reason the characteristics of a petrographer are an ideal, to be followed rather than attained. He should possess the following major qualities, the order of importance of which will vary according to the type of research undertaken, and according to whether the worker is to plan or to execute the program: health, accuracy, application, zeal for investigation, reasoning power, alertness, originality, memory, co-operation, and moral attitude.[3] A man having these qualities will have benefited by his education and experience in geology, without which geologic knowledge will not "take"—he will have been immune to all inoculations. Intensive and extensive knowledge of geology increases greatly the value of a petrographer's work. A firm grasp of fundamentals, however, combined with the above ten qualities, will cover all needs. The quality of co-operation is fulfilled by frequent reference to standard texts. Reading is the least expensive type of research, and it is almost impossible to do too much of it.

By diligent reference to the work of others and thoroughness in the details of his own work the petrographer greatly reduces the philosophic element. Such co-operation and accuracy of detail give correct interpretations which to workers in more exact sciences are based entirely on a priori reasoning and analogy. As an example, there are the chalcedonic forms of silica which all geologists accept as having formed at low temperatures, low pressures, and most probably from colloidal material.[4] Yet an extremely able scientist,[5] who has exhaustively studied silica in all its forms, says that the chalcedonic form has not been proved to mean anything as to chemical environment or as to temperature. Good judgment in such cases consists of knowing when geology is still groping its way and when it is pointing the way out for its more exact sister sciences. Such good judgment does not indicate a super-intelligence. It merely results from that pleasure in one's work which is always accompanied by those important qualities: contemplation and the capacity for infinite detail.

Before work is started, the question to be answered should be stated as clearly, simply, and concisely as possible. Conciseness is least important. Every attempt must be made to avoid using words which involve theories not intimately related to the problem. Such formulation of problems allows the mining industry to estimate the possible practical value of geologic research. Geologists' habitual vagueness has failed to win over the foresight of mining corporations. In sciences other than geology results of pure and applied research come largely from a conscious pursuit of a pre-defined goal. The advance of science is being less and less entrusted to chance and phalanx attack. Geology is an inexact science, yet again and again it has pointed out to the more exact sciences the right path to truth. Those geologists who recognize that for the present their science has outgrown its stage of hypotheses can materially shorten the transition period of misdirected energy and general chaos. They will step boldly into a period of fewer and more clearly defined hypotheses—a stage of consolidation. (A sign of the times in the last twenty years has been the increasing number and completeness of bibliographies in geology.) Such workers as can do this will determine by a consciously designed plan, or plans, the rate of future progress in geology. Thus, at the start, an unrelenting attack on the philosophic element is rewarded. The most direct approach to the problem becomes clear, and time spent on superfluous interpretations is minimized. By formulating the problem, a worker's mind is kept from wandering into irrelevant bypaths. He can make decisions with dispatch and confidence, as to relevancy of a reference in the literature, or of a detail in his own work. He will find it possible to estimate the time necessary for the work, and to forecast the definiteness to be expected in his results.

Collection of Samples

When the question to be investigated has been formulated, to locate samples so that a few of them will be enough is both possible and practicable. Museum specimens or grab samples are of less value than they would be for estimating the metal content of a block of ore. Samples must be accurately located and as much information as possible concerning their geologic setting should be collected in the field. Because of the blending of nature's processes, a series of samples from one end member of a geologic phenomenon to the opposite end member will often make a valuable sequence.

Too many samples cannot be taken. If necessary, the petrographic evidence can be given great weight by the force of numbers. Moreover, a few samples do not take into account the complexity of geologic processes and will be far from representative enough to justify general conclusions of great value. On the other hand, a large number of samples insures the inclusion of some that will simplify the interpretation of much uncorrelated data. They might be termed "key samples," there being no alternatives in interpreting data they contain. They save a time-consuming compilation and correlation of data, which, without them, may not have been definite enough in its tendency toward one interpretation or its opposite. Examination of a large number of samples will cut into several phases of the philosophic element. The uniqueness of a deposit will often be found more apparent than real. And, the field of investigation being a genetic unit, but slight reference need be made to general geologic theory.

[3] "Opportunities for a Career in Scientific Research." National Research Council, 1927.
[4] Waldemar Lindgren: "Mineral Deposits"; 1928, p. 214.
[5] Robert B. Sosman: "The Properties of Silica"; 1927, p. 787.

The small number of sedimentary rocks that have been studied were not so satisfactory as those of igneous origin, especially those that were definitely crystalline. Lack of igneous rocks may in some research force the use of sedimentary rocks, but work will have to be done before assuming them to be satisfactory. On general considerations, it is easy to judge that igneous rocks will allow more definite conclusions, and experience shows that they are quite definite. Igneous rocks are usually quite uniform in mineral composition, and in texture, over large areas; the amount of gangue present can thus be expected to indicate delicately the relation of the sample to orebodies. Minerals common to igneous rocks are more susceptible to weak altering agents than those common to sedimentary rocks; this allows several intensities of alteration to be distinguished easily.

Correlation of Field and Microscopic Evidence

Several possible combinations may be used for bringing microscopic evidence in touch with field data. The best practice is for the petrographer to do his own field work. When this is the plan adopted the responsibility carried by one man is large, and proportionate caution should be used when employing him. He must be a geologist, as well as a petrographer, and preferably a mining geologist, in which event he can make interpretations as final as possible while the observation is being carried on. This is a good key to success in applied petrography. It is possible to accept with great confidence the conclusions from such interpretations. When all data are assimilated by one man of the right capacity, he will see clearly to the heart of the problem. He will reduce the philosophic element by making the most direct attack. And distinction in the problem between real and apparent complexity becomes obvious sooner. When the petrographer does only that field work essential to a proper selection of samples, and especially when he does no field work, frequent conferences with the field man are advisable. The procedure least of all to be recommended is that in which the field man and petrographer draw up their final reports entirely independently of each other. Each tries to stay in his own province, and, as the boundaries are very arbitrary, almost any other arrangement will under most circumstances be more satisfactory.

Team-Work of Laboratory and Field Men

Many of the competent petrographers are bound to universities by research and teaching ties, and usually they would not be in a position to do much field work. Under such circumstances the field man and the petrographer must each be thoroughly acquainted with the limitations and difficulties under which the other has to work. This results in a spirit of toleration and co-operation which are indispensable. The field man should recognize that good petrography is as much field work as are observations made with the unaided eye. A simple way of recalling the limitations of the microscope is to remember that it works with samples only 20 mm. ($\frac{3}{4}$ in.) in diameter. Wherever a geologic term is used, one can easily grasp its relation to petrography by reference to the correct definition of the term. Definitions which involve dimensions greater than $\frac{3}{4}$ in. are, in general, outside the scope of petrography. Field examination, for example, will distinguish best between a dike and a conglomerate, or between a sill and a batholith. On the other hand, some questions belong peculiarly in the realm of petrography.

Thus, when a petrographer concludes that one rock is an alteration product of a second rock, or that a mineral is gangue and not primary to the rock, such conclusions must be accepted largely on faith. He knows better than the field man, or should know, the criteria used as a basis for decision. The petrographer works constantly at magnifications allowing a field of view only 0.8 mm. in diameter. As the sample in an average thin slice is 20 mm. in diameter, 500 photographs, as shown by computation, would be necessary to cover one thin slice. In good petrography, therefore, the worker's convictions result from a formidable host of observations, and to check many of them is impracticable. After he has tabulated them as well as is practicable, in a statistical summary, they may often be doubted by the field man. In such an event, one solution, or a combination of four solutions, may be employed—that is, submit the question to an umpire agreed to by both; or the field man can do some or all of the petrography, or he can hire a new petrographer. If the field man has a basis for faith in his petrographer, he may choose to be convinced by discussion.

(To be continued)

Gypsum and Anhydrite Retarders for Portland Cement

THE investigation of the fundamental factors involved in the utilization of various forms of calcium sulphate as retarders for portland cement is being continued at the Non-metallic Minerals Experiment Station of the U. S. Bureau of Mines, at New Brunswick, N. J. Thus far the investigation has shown that plaster of paris, gypsum, and anhydrite differ greatly in their retarding properties and give different plasticities to the resulting products. They also show that anhydrite can be used alone only under certain peculiar circumstances, although it is satisfactory in mixtures with other calcium sulphates. The results to date have been prepared for publication as a Technical Paper.

One of the important factors shown by this investigation is the degree of fineness to which the cement and the retarder are ground. This has not been thoroughly investigated heretofore. The New Brunswick station is constructing apparatus for the separation of finely ground cement, gypsum, and anhydrite into fractions of definite particle size, using the air classification method preparatory to studying the time of set of the various fractions of typical portland cements as compared with the time of set of these same fractions when mixed with various percentages of gypsum or anhydrite of definite particle size.

Testing Ontario Iron Ore Deposits

INTEREST in the iron deposits of western Ontario has resulted in the shipment of a full carload of ore to Ottawa for testing, according to the U. S. Department of Commerce. From tests on such a large quantity, data indicating the actual commercial possibilities of the ore, and whether or not ore from this source can be utilized as a source of supply for Canadian furnaces, are to be obtained.

The ore to be tested is from Kaministiqia, where deposits estimated to contain several million tons are reported to exist.

Humanizing Geology

CHARLES N. GOULD

IN OKLAHOMA we are now placing the guide book by the side of the road. The Lions Club, of Ardmore, aided by the Ardmore Geological Society, has placed by the side of the new highway, north of the city, a dozen signboards descriptive of the various geological formations exposed on the surface in the Arbuckle Mountains. The Arbuckle Mountains of southern Oklahoma are an object lesson in geology. Those who know say that in no single area of similar size in the United States are there so many geological features as in this region. With the exception of glacial phenomena and volcanic phenomena, almost the entire gamut of geology may be observed in these mountains.

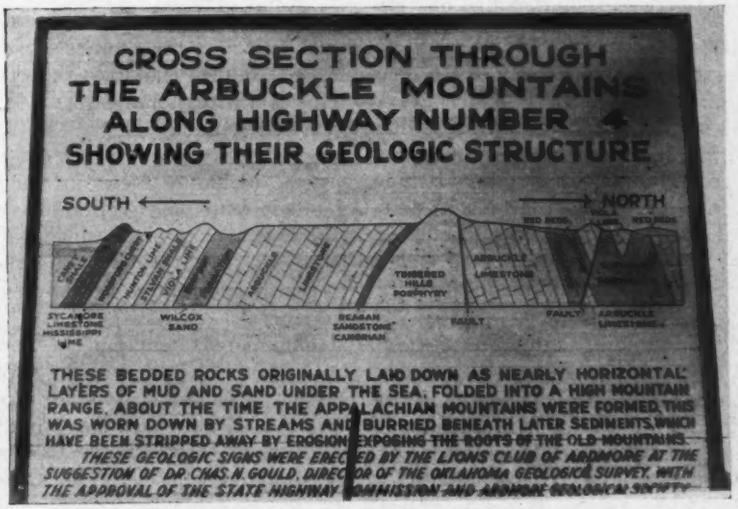
To go a long way back, toward the beginnings of geologic history, in far-off Cambrian times, the area where the Arbuckles are now located was a shallow sea. The first rocks deposited in this sea and the oldest stratified rocks in Oklahoma were sandstones and arkoses washed in from some near-by land. This is the Reagan sandstone. The sea gradually deepened, and for long eons limestone was deposited, one layer after another, until a total thickness of about 8,000 ft. of limestone had been formed. This is the Arbuckle limestone, a great series of massive ledges, one of the thickest limestone formations in America.

After the deposition of this massive limestone, the land again rose and a formation. 1,500 ft. thick. was deposited. This is the Simpson formation, composed of sandstones, shales, and thin limestones. Sands of the Simpson formation are quarried for glass sand, and in other parts of Oklahoma this sand is called the "Wilcox" oil sand. In the Seminole oil field, during the last year, this sand, which is encountered in wells more than 4,000 ft. beneath the surface, has produced as much as 500,000 bbl. of oil per day. Other members of the Simpson formation are Burgen sandstone and Tyner shale. Lying above the Simpson is the Viola limestone, 800 ft. thick; then, in ascending order, are the formations known as the Chimneyhill limestone, Henryhouse shale, Haragan marl, Bois d'Arc limestone, Woodford chert and Sycamore limestone. The total combined thickness of the various formations is about 12,000 ft.

All these formations were deposited during lower Paleozoic time; the Reagan is Cambrian in age; the Arbuckle is Ozarkian and Canadian; the Simpson and Viola are Ordovician; the Sylvan, Chimneyhill and Henryhouse are Silurian; the Haragan and Bois d'Arc are Devonian; and the Woodford and Sycamore are Mississippian in age. There are in the series many erosional unconformities, representing times during which the area doubtless stood above the ocean, when erosion cut away existing land masses, and no deposits were laid down.

At the close of the period of deposition just described, which extended over many million years, there came a period of orogeny, or mountain making. Great stresses and strains were set up, which compressed or squeezed together the rocks. The entire area now occupied by the Arbuckle Mountains was uplifted like a gigantic blister, 60 miles in length, and the rocks which were originally deposited as level-lying sediments in the various Paleozoic seas were uplifted and tilted so that near the periphery of the range the various ledges now stand on edge, often at an angle of 90 deg. from their original position.

A sign erected by the road near Ardmore


CROSS SECTION THROUGH
THE ARBUCKLE MOUNTAINS
ALONG HIGHWAY NUMBER 4
SHOWING THEIR GEOLOGIC STRUCTURE
SOUTH
NORTH
SYCAMORE LIMESTONE MISSISSIPPI
WILCOX SAND
REAGAN SANDSTONE CAMBRIAN
TENKILLER HILLS PORPHYRY
ARBUCKLE LIMESTONE
FAULT
FAULT
ARBUCKLE LIMESTONE
THESE BEDDED ROCKS ORIGINALLY LAID DOWN AS NEARLY HORIZONTAL LAYERS OF MUD AND SAND UNDER THE SEA, FOLDED INTO A HIGH MOUNTAIN RANGE. ABOUT THE TIME THE APPALACHIAN MOUNTAINS WERE FORMED, THIS WAS WORN DOWN BY STREAMS AND BURRIED BENEATH LATER SEDIMENTS, WHICH HAVE BEEN STRIPPED AWAY BY EROSION EXPOSING THE ROOTS OF THE OLD MOUNTAINS.
THESE GEOLOGIC SIGNS WERE ERECTED BY THE LIONS CLUB OF ARDMORE AT THE SUGGESTION OF DR. CHAS. N. GOULD, DIRECTOR OF THE OKLAHOMA GEOLOGICAL SURVEY, WITH THE APPROVAL OF THE STATE HIGHWAY COMMISSION AND ARDMORE GEOLOGICAL SOCIETY

Abstract of a paper by Dr. Charles N. Gould, of the Oklahoma Geological Survey, in *Science Monthly*.

After the elevation of the mountains, erosion at once began to cut down the rocks and carry the débris into the ocean. This process is still in operation.

Geologists who have studied the matter are not entirely agreed as to whether the elevation of the Arbuckle Mountains took place in a comparatively short period of time, so that the mountains once stood more than two miles above their present level, or whether the uplift was accomplished so slowly that erosion about kept pace with the elevation of the rocks. Whichever method obtained, the fact remains that at present the mountains as a whole have been planed down until the general surface consists of a comparatively level plateau, lying at an elevation of about 400 ft. above the level of the surrounding country.

Streams taking their rise in this plateau and flowing toward the north have eroded canyons, and at the place where these streams have cut their way across the upturned ledges of the hard limestones one finds many beautiful waterfalls.

United States Highway No. 77 crosses the Arbuckle Mountains north of Ardmore. This is one of the main arteries of travel north and south across the states of the Great Plains. The days of the covered wagon and the deep-rutted roads are over, and today hard-surfaced highways checkerboard Oklahoma. Arbuckle Mountains, extending east and west, interposed their bulk across the main line of communication from north to south.

The Santa Fé railroad detoured several miles to the east and found a water gap at the place where the Washita River had sawed its way downward through the heavy limestones. But the highway, seeking a shorter course, climbs the Arbuckle Mountains and runs for 6 miles along their crest. Thousands of cars daily travel this highway. It is along this highway, where the grade winds down the south side of the Arbuckle Mountains, that the guide-book signs have been placed, calling attention to the various formations crossed by the highway. And surely no better place could have been found. In grading the road across the mountains, it was found necessary to blast away many of the ledges, laying bare exposures of rock not previously seen.

In Oklahoma, geology is no longer a strange thing. The people of the state do not look upon geologists as either pedants, freaks, or soothsayers. Geology has today taken its place among the professions. In Oklahoma nearly 1,000 men follow the profession of geology.

At the State University, at Norman, 90 miles north of the Arbuckle Mountains, a geological faculty of 15 men instructs over 1,300 young people. Practically every large city in the state has its geological society. It is due largely to the labors and investigations of these men that Oklahoma today ranks second among the states in mineral production. The geologist has been largely responsible for the discovery of the three hundred oil fields of the state, that last year produced petroleum products valued at approximately $500,000,000 and made the state the leader in the country in this respect.

And it is in the Arbuckle Mountains that many of these geologists first received their early training. For many years it has been the custom to conduct field parties from the State University and from other schools in Oklahoma and adjoining states into the Arbuckle Mountains. It has been estimated that during the last two decades 5,000 young people have studied formations and collected fossils in these mountains.

So that it was the logical thing for the Geological Society of Ardmore to stand sponsor for the idea of labeling the rock formations of the mountains along the newly constructed highway near their city.

The moving spirits in the matter were myself and Dr. C. W. Tomlinson, a graduate of the University of Wisconsin and the University of Chicago, who is practicing his profession as geologist for one of the petroleum companies operating in Oklahoma. He is also a member of the Lions Club, of Ardmore. Some two years ago Dr. Tomlinson began to agitate the matter, and succeeded in interesting the members of the Lions Club in financing the undertaking.

Soon after the completion of the highway the signs were erected by the roadside. Eleven of these signs, each describing a single formation, are four by five feet in size, substantially placed, and should last for many years. The largest sign, located on the highest point along the highway, is eight by twelve feet in size and contains a diagrammatic cross-section of the Arbuckle Mountains.

In true Western style, every one co-operated. While Dr. Tomlinson led off and the Ardmore Lions Club stood sponsor for the finances, other agencies contributed in various ways. The Chamber of Commerce and the Ardmore Geological Society gave assistance. The State Highway Commission varied an established rule and gave permission for the erection of the signs on the right-of-way.

And the people use the signs. It is no uncommon thing to see half a dozen cars lined up by the roadside and the tourists studying the cross-section and reading the description. In distant states one hears remarks anent the geological signs in the Arbuckle Mountains at Ardmore.

The effect is good. The guide book is by the roadside. He who runs may read, and as he reads the descriptions on the signs and studies the rocks to which the signs refer, he gets an idea of what it is all about.

Thus, in Oklahoma, we are humanizing geology.

The Miner's Bible

THE monograph on the Leadville mining district, Colorado, published by the U. S. Geological Survey in 1886, became a source of constant reference and a guide to people in the mineral industry, and was frequently called the "miner's bible." In 1927 the Survey issued another elaborate report on the Leadville district. This is Professional Paper 148, often referred to as the "revised version" of the "miner's bible." It draws extensively from but greatly augments the original monograph, including new information and many colored geologic maps and sections based upon repeated visits to the district, especially since 1900. This volume of 368 pages has been widely acclaimed for its value not only to the district but to the mining industry and to geology in general.

This paper has been in great demand, but as it is unlikely that there will be another report on the same subject, a rather large edition of the paper was printed, and copies may still be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., for $2.50 each.

Peru—A Land of Progress and Promise

THE ANDES RANGE, the backbone of South America, divides Peru into three perfectly distinct zones—The coast, bordering the Pacific Ocean and limited to the east by the Andes; the Sierra, or highlands, between the two branches of the Cordillera; and the lowlands, montaña, or region of the forests, on the eastern side of the range.

The aelysian winds, predominant in the oriental zone of South America, blow from the southeastern direction and travel over the flat portion of the continent, charged with moisture absorbed from the Atlantic Ocean. On reaching the Andes, which, like an enormous barrier, intercept their passage, they have to expand to overcome the obstacle, and in so doing, part of their latent heat is absorbed, thus producing the condensation of almost all the water vapor they carry, which precipitates as torrential rains. The remainder of the moisture is condensed in the cold highlands, mostly as snow. So the winds from the east that reach the Pacific slope are completely dry.

Because of these conditions the hydrography and climatology of the three regions is widely different. The coast is a narrow band of arid plains interrupted here and there by cultivated valleys, nourished by a few rivers, descending from the Cordillera embanked within stirrups of the Andes and flowing into the Pacific Ocean. The climate is mild, notwithstanding the latitude, because of the cooling action of the Humboldt antarctic current and the vicinity of the ice- and snow-covered summits of the Cordillera. The Humboldt current is also a contributor to the lack of rain on the Peruvian coast, as its low temperature does not permit the evaporation of water, so that the mild winds from the south are also dry.

The highlands, or sierra, is an abrupt country and contains, between the two branches of the Andes, high plateaus such as the plateau of Junín in the center and Titicaca in the south, which is the largest of the two. The difference between these plateaus is that although the rivers, born in the mountains bordering that of Junín, flow into the Amazon by breaking through the low passes of the oriental branch of the Cordillera, those in the south form a separate basin, that of the Titicaca, and create an immense navigable lake at 12,500 ft. altitude, which, unless provided with an underground outlet, loses by evaporation the enormous amount of water carried into it by many rivers. The climate of the highlands is cold but dry.

On the eastern slope of the Andes, the permanent moisture and the higher temperature produce luxuriant vegetation. The heavy rainfalls create torrential rivers with deeply excavated beds, forming wonderful canyons, and making a broken but magnificent country. Further east large rivers that flow into the Amazon cross immense low plains covered with tropical vegetation.

Metal mines are scarce in the coastal zone. Only in the southern region, where a portion of the Pacific chain remains emerged, copper porphyries and veins of copper and gold are found. Iron is abundant as magmatic segregation of basic rocks (basalts). The Marcona deposit, only 10 miles from the ocean, contains in the outcrops from 50 to 60 million tons.

Oil is found in large quantities in the coastal zone of northern Peru as well as lignite and sulphur. Alkaline salts and waters likewise abound in many places in this zone.

The Sierra is, as could be expected, the most intense and diversely mineralized region. Here lie the majority of the mines of silver, copper, lead, zinc, antinomy, bismuth, vanadium, molybdenum, tungsten, mercury, nickel, cobalt, and manganese. I will not go into details of the immense mineral wealth of Peru, as it would take me too long. I will only point out that on account of the gold and silver content of its copper ores, Cerro de Pasco is the cheapest producer of copper in the world and that Peru is until now the only possessor of a deposit of vanadium minerals.

Tin has recently been discovered in southeastern Peru. In one of my articles on the mining industry of this country, published by the *Engineering and Mining Journal* on June 9, 1917, I expressed my opinion that it was an error to suppose that the tin-bearing chain of turmaliniferous granite of Bolivia would enter Peruvian territory in the neighborhood of Lake Titicaca. My geological studies in the Carabaya region led me to believe that the tin-bearing formation was to be found in the province of Sandia.

Bituminous and anthracite coal are very abundant, as well as asphaltites. Petroleum is also found in the highlands of Cuzco.

The jungle is also a gold region, many affluents and subaffluents of the great Amazon River carrying gold. Pataz, east of Salaverry, is a very promising gold district, and the enormous Silurian basin extending over the provinces of Sandia, Carabaya, Quispicanchis, and Paucariambo of southeastern Peru contains gold in unusual quantities in rivers, placers and veins, that, when properly developed, will surprise the world. Oil is abundant along the eastern side of the Andes, from Colombia and Venezuela to the extreme southeast. Comodoro Rivadavia, in the Argentine, including Peru and Bolivia, thus constitute a large oil reserve for future generations.

Being torrential, most of the Peruvian rivers, as they descend from 15,000 ft. to almost sea level in a distance of from 60 to 100 miles, are potential sources of hydraulic power.

A country so richly endowed by nature as Peru has a great future before her. The large diversity of her products is a great advantage, not only because while some of them might be at a low price in the world markets, others command a high price, establishing a compensation, but also because of the possibility of becoming in a near future almost self-sustaining, thus solving the problem of international exchange.

Native capital is not yet sufficient to develop intensively our natural resources; we need the help of foreign capital and we feel sure that it will profit from the opportunities offered by a country that has already acquired political stability and has liberal laws. There is not one single foreign investment of capital in Peru that is not profitable.

Excerpts from an address delivered by F. C. Fuchs on the occasion of the visit of President-elect Hoover to Lima, Dec. 5, 1928.

PLANNING AND DESIGN OF HOUSING AND CO

TO EFFECT
Economy of Construction
and
Low Heating Cost

TO SECURE
Comfort . . . Convenience
and
Reduction of Fire Hazard

This is the second of a series of articles by a mining engineer well known in the United States and in Canada, in collaboration with a distinguished Toronto architect. The authors consider the appearance of the settlement, and recommend minor varieties of design that involve negligible additional expense. Suggestions follow in an endeavor to secure maximum structural efficiency at minimum cost, with particular mention of the application of gypsum insulation. A concluding installment of the series will give a detailed description of the typical buildings constructed according to the recommendations made by the authors in these highly informative articles.

A DWELLING HOUSE in northern climates should be adapted to local conditions and not be designed to follow precedents established in localities further south. The most economical house to build and maintain is the story-and-a-half type, without dormers or other breaks in the roof. Little hoisting of materials is necessary, and the amount of scaffolding required during construction is small, which is not the case with higher structures; the cost per cubic foot of inclosed space is less than in other types; plumbing and heating arrangements can be grouped better than in the bungalow of equal capacity; and surplus heat from the first-story rooms keeps the upstairs rooms comfortable. The disadvantages of this type are the uncomfortable heat in the upper rooms during hot weather, and the stair travel where there are small children or invalids. The first objection is disposed of by insulation, and the second objection is reduced by locating the bathroom on the first floor. Objection may be raised to the ceiling cut-offs under the roof, but this is not serious if the vertical portion of the wall is sufficiently high to extend above the usual furniture. The two-story semi-detached type — two distinct houses separated by a party wall—is cheaper to build than two separate houses, and by using an insulated, fire-safe, and soundproof wall, the lack of privacy is largely overcome.

The houses may be plain, and a diversity in group appearance can be gained by differences in the shapes of porches, by various types of front and side entrances, by small cut-backs of the ridge lines, and by varying the paint colors of body and trim. With these differences, which do not materially add to the cost, even two types in a group will give sufficient contrast without providing expensive and unnecessary details. However, in extensive developments, with long lines of houses, a few two-story or duplex structures or community buildings interspersed will improve the appearance of the project.

Three or four types of dwellings will usually cover all needs, and will avoid the expense of designing and constructing a greater variety. The number of rooms will be from four to seven, with additional bathrooms and hallways. One type, and the cheapest satisfactory house that can be built to include any of the desirable features that have been outlined, will contain a kitchen, a living room, two bedrooms, and a wash or toilet room with tub or shower bath where this is possible. Such a house will cost from $1,600 to $2,200, complete and ready for occupancy. This type is satisfactory for the use of miners or laborers with small families, and can be rented at a figure within their means. A second type with more conveniences and better finished, with four to six rooms and bath, will cost from $2,600 to $3,200 and is suitable for men with larger families and for foremen and members of the staff. A third and much better type, suitable for executives, will cost from $3,500 to $6,000. These prices are suggestive only, but should cover construction in localities where railroad transportation is not more than a few miles distant, and they are based on costs of labor and material prevailing in northern mining camps of the Canadian provinces during 1928. To come within these costs requires careful planning, efficient supervision, and the omission of unnecessary architectural features. Some examples of the types mentioned will be given later in this paper.

The table presented on this page, giving desirable minimum requirements for sizes of rooms, has been adopted by the various Ontario housing commissions under which about $15,000,000 has been expended in small-house construction:

	Area in Square Feet	Narrowest Dimension, in Feet
Living room	144	11
Dining room	120	10
Kitchen	80	8
Bedroom No. 1	120	9
Bedroom No. 2	100	8
Bedroom No. 3	75	7
Bathroom	35	5

Minimum height of ceiling, 8 ft.
Window area of rooms, minimum, 12 sq.ft.
Window area of bathroom, minimum, 6 sq.ft.

These minimum allowances can be exceeded at the costs given. If the living room is less than 16 ft. in one dimension, the kitchen should be made large enough to use as a dining room, this arrangement being preferred by many families. Unless electric heat is used for cooking, the kitchen should not be small, as the heat from wood or coal ranges becomes unbearable in hot weather. The arrangement of rooms should allow entrance from any room to any other room or to the

By HARRISON E. CLEMENT *and* JAMES GOVAN

COMMUNITY BUILDINGS

bathroom without passing through a third room, this arrangement also allowing the most flexible manner of heating. This can be accomplished by placing a small interior hallway on the ground floor at the foot of the stairs leading to the upper story, which should not be connected with the main entrance in the low-cost and medium-cost house. A large entrance hallway opening into the different rooms takes up costly space that can be used to increase the sizes of the rooms. In some designs of small houses such an entrance hallway takes up from one-fifth to one-half the ground-floor area. No objection should be raised to entering the living room directly from a protected porch or a small hall, if these are fitted with hooks for outdoor clothing. A protected outside kitchen entrance should be provided that may be used for fuel supply and as a washroom in summer.

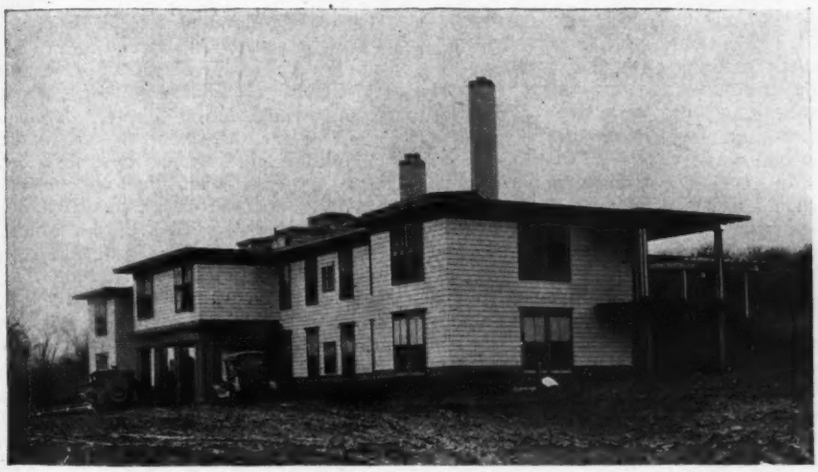


FIG. 2—STEVENSON MEMORIAL HOSPITAL AT ALLASTON, ONT.

The largest item of saving in construction cost is the omission of the usual cellars and concrete foundations. The building can be carried on concrete piers with their bases below frost level, or on creosoted cedar posts; and the floor should be well above the ground, to give good ventilation and to provide access to piping. Insulating the floor will keep it warm; but, if this is not done, the sides of the house should be carried down to ground level in the form of a double-boarded wall with asphalt felt between the layers, and dependence placed on the natural heat of the ground, added to some heat leakage through the floor, to keep the space fairly warm. Sewer and water pipes can be carried below frost level in a protected wooden box. If an insulated floor is used, a plain lattice or slat-work may inclose the under space. If a cellar is desired it should not be large, and a plan is shown in Fig. 1 which gives sufficient space for fuel storage, furnace, vegetable bin, and work bench. If a furnace is required where the rocky or swampy nature of the ground would make a cellar too costly, it can be placed in a small insulated addition at the ground level, but under these conditions a hot-air furnace is not satisfactory without fan circulation.

The use of some type of fire-resisting wall board is to be recommended instead of the usual lath and plaster. Many types of these wall boards are available that afford a more efficient insulation than does the plaster finish. Their chief utility is that they become an integral part of the structure, and tests have shown that such wall boards nailed on 2x4 in. framework will resist a large distortion load. Tested against similar panels of 1-in. board, nailed on 2x4-in. framework, the resistance against distortion of the wall board to point of failure is several times that of the board sheathing. This use of wall board on partitions and walls greatly increases the rigidity of the building, and examples will be given where all outside sheathing has been omitted and full dependence for stiffness placed on the interior wall coverings. The wall board should be put on with rustless nails to prevent discoloration, and it can be finished in a variety of ways: by filling the joints or covering them with panel strips and painting or calcimining; by applying a rough or smooth plaster coat directly on the board; or by covering with paper or other material. It is preferable to paint the ground-floor rooms with some hard-surface washable varnish-base paint, rather than to calcimine them, especially where there are children in the family. The colors should be harmonious and restful: light browns, tans, buffs, or similar shades for living rooms, with ceilings of a lighter shade; cream or white, or a light tinge of blue, for kitchens and bathrooms; light buffs, pinks, or salmons for the bedrooms. A dull or stippled surface for the walls is more pleasing than a glossy surface and tends to obscure the joints where paint is applied directly to the wall board. Trim in living rooms may be stained if it is clear material, but other trim should be painted. The hardware should be plain and should have a durable finish. Bower-Bàrf fittings have been used extensively in buildings of this kind.

Storm or double windows are necessary in very cold climates, for protection and to keep the glass areas clear of the frost that collects on a single thickness of glass and entirely obscures the view and keeps out the sunlight for weeks at a time. These can be fastened to the outside trim; but a better method is to hang them from the top in such a manner that the storm window can be swung out and held open in mild weather or for night ventilation. Several fixtures are on the market for doing this. All storm windows and screens that have to be taken off in summer should have the fastenings put on, or the screwholes bored to a templet so that they will be interchangeable. Storm doors and screens are desirable and not expensive, as they can be made by the house carpenters. The screens should be at least 18-mesh to keep out the smaller insects that infest the north country, and should be galvanized or made of copper, bronze, or Monel-metal wire.

Buildings used as living quarters by men without families are usually two or more stories in height. They should be made suitably attractive and comfortable, to retain a desirable force of employees. The staff men are preferably housed in a separate building, but they may use the lower floor of a general dormitory, this being divided into one-man rooms and with reading and recreation rooms. The use of

sound-proof and fire-safe walls and floors removes the main objections to this arrangement if common, or living, rooms are provided on both floors. An example of such a building suitable for fifty men will be given later. Such buildings will usually have a much greater length than width, with sleeping rooms on each side of a central corridor. They should be oriented with the common room toward the south, if this is in one end of the building, to give sunlight in all rooms at some part of the day, and placed well away from the noise of power or other machinery, and from smoking chimneys or stacks. Preferably they should not be in the same building with boarding arrangements, because at meal times the noise made by men of other shifts disturbs those who are sleeping, where there is two- or three-shift operation.

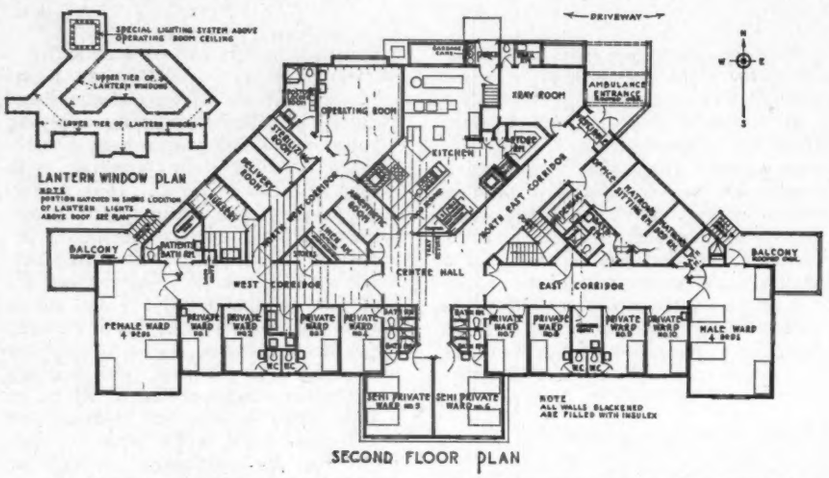


FIG. 3—SECOND FLOOR PLAN OF THE HOSPITAL SHOWN IN FIG. 2, WITH INSULATED FRAME CONSTRUCTION

The usual type of structure has a pitched roof with unused attic space; but, with the development of insulated construction, these roofs can be made flat or slightly pitched, with the advantages that they can be constructed at a considerably lower cost, and that some of the snowfall will remain on the roof to assist the insulation in retaining the interior heat, for snow is an excellent insulator. In northern climates east of the Rocky Mountains the snowfall is not heavy, and it will not accumulate to any great depth, because the wind sweeps away any excess. The interior partitions give ample strength to provide for snow load; and insufficient heat transfers from the interior to melt the snow on the roof and form an ice load, as is shown by the noticeable absence of heavy icicles. In summer, the insulation will keep the rooms directly under the roof as cool as the first-floor rooms. These flat roofs should be without parapets or other obstructions that might cause the snow to bank up in winter, and can be made with a wide projecting cornice to protect the walls and open windows from rain. A building of this type, insulated and fire-safe, and with main interior partitions almost soundproof, can be erected for less than the ordinary frame type of structure having the same interior finishing. The advantages of insulated and fire-safe construction are similar to those in dwelling houses, with the added if incidental feature of sound-proofing, a boon to men requiring sleep in the daytime or at odd hours.

In general, not more than two men should use one sleeping room. With the usual type, having a central corridor with rooms on each side and with steam or hot-water heating, all the radiators may be placed in the corridor, and this is then kept at a considerably higher temperature than the desired room heat, the separate rooms obtaining their heat from open transoms or doors. This method effects a marked conservation of heat, avoids the freezing of radiators, and reduces the cost of piping and installation. Each room can be kept at the temperature desired by its occupants.

A bathroom and toilet may be provided on each floor, or only on the ground floor, with direct access from the corridor of each floor. Self-closing, heavy swing doors should shut off the common rooms from the corridors, to keep noise from the sleeping quarters and to retain the corridor heat, and the bathrooms should have sound-proof partitions, and self-closing noiseless doors opening into the main corridor. Bathrooms and washrooms should have a drained concrete or tile floor brought up about 6 in. on the walls. The common rooms may be furnished with comfortable chairs, reading tables, card tables, books, and magazines, and the men usually take more interest in the upkeep of such a room if they are allowed to contribute to such features as phonographs, radio sets, and other amusement fixtures.

If stoves must be used for heating, the design of the building can be changed to advantage so that the common room is in the center of the building, which will distribute the heat more evenly, but this arrangement is not so desirable, for noise cannot be kept from the sleeping quarters, and three-side exposure of the living rooms to the sunlight is impossible.

Hospitals, Schools, Community and Other Buildings

The problem of providing structures such as schools, hospitals, churches, and other buildings for social activities in an industrial development differs little from that of housing. The fire-resisting, insulated, frame construction described in this article can be used for outside walls, inside partitions, floors, and roofs, so that temperatures that would melt ordinary brickwork can successfully be withstood without danger of fire spreading and with slight damage to the frame structure.

Furthermore, the question of obsolescence in buildings such as hospitals and schools is one that has received far too little consideration by those intrusted with their development, the tendency having been to use such solid construction for these institutions that they are antiquated long before they have commenced to deteriorate.

The Stevenson Memorial Hospital, at Alliston, Ont., shown in Figs. 2 and 3, is in construction simply a development of the details illustrated in the dormitory building just described, but with gypsum sheathing outside the studding, covered with asphalt felt and clapboards, and with a plaster or tile finish throughout the interior, and sanitary floors where required. The plan (Fig. 3) shows the second floor only; the first floor, which is at grade level all along the south front, provides accommodation for seven patients, together with a sitting room and bedrooms for five nurses, an outpatient department, and clinic rooms, laboratory, heating plant, laundry, store rooms, and a screened-in veranda. The intention is that this hospital will become more and more a rural health center, and that, as its activities develop, a separate cottage for nurses and staff will be built and their present quarters added to the accommodation for patients, bringing the total to 32 beds.

The cost of the building, not including furniture and special hospital equipment, but including the finishing, plumbing, wiring, and heating plant, complete for all rooms on both floors and ready for their future use as a 32-bed hospital, was slightly under $2,500 per patient.

As proof that the type of construction will satisfy the most rigid specifications for institutional or other buildings, it may be stated that in planning and equipment this hospital meets the exacting requirements of the Standardization Committee of the American Hospital Association, notwithstanding the fact that the cost of the building was considerably less than that of most hospitals providing anything like similar accommodations. One of the leading hospital authorities

on the American continent has expressed the opinion that he doubts whether any other hospital has been erected giving equal accommodation, safety, and facilities for the care of patients, for anything less than from 30 to 50 per cent more money per patient. To these facts it can be added that the fuel consumption of the building, had it been built of the ordinary uninsulated construction, would have been at least half again as much as it is, and that in the matters of sound transmission, sound absorption, sunlighting, and other features, the structure has many advantages that cannot be detailed here.

The insulating material used in the structures described and illustrated in this paper is a calcined gypsum product manufactured under various names by gypsum companies in the United States and Canada.[1] It is shipped as a powder in paper sacks holding 50 lb. When mixed with water, some of the ingredients react and evolve a gas, the mass swells or "rises" and is poured in place while still plastic and expanding. After the action ceases, the gypsum sets in 20 to 30 min. as a cellular pumice-like solid, containing a large proportion of small gas cells separated by thin gypsum partitions. In this form it is an excellent insulator and has about the same heat resistance as cork. To obtain a heat resistance of ten hours, which is approximately what should be added to wood construction in larger buildings, requires 3.33 in. thickness. Other materials to give the same resistance require thicknesses as follows: fibre boards, $\frac{7}{8}$-in. thick, 7.55 layers totaling 3.3 in.; cork board, 3.2 in.; hair felt, $\frac{7}{8}$-in. thick, 16 layers; solid wood, 12 in.; brickwork, 50 in.; concrete, 80 in.; and stonework 86 in. These figures indicate how little insulation we get from concrete, brick, or stone building materials, and how necessary is some addition of other insulation in even the most expensive construction. Wet-poured gypsum products used as fillings in walls, roofs, and floors of buildings in the manner to be described make the structure fire-safe, insulated, partly soundproof, and keep vermin and rodents out of the walls. They are entirely mineral, do not disintegrate with age, and can be obtained to give products of different weights ranging from 8 lb. to 30 lb. per cubic foot after setting. The 8-lb. variety is suitable for filling walls, ceilings, and floors, and is the weight used in the buildings described. A medium weight of 18 lb. per cubic foot is used for pre-cast work or where the material must be walked upon during construction and as a base for tile or cement floors. A 30-lb. weight is used where structural value is required. Naturally, the insulating value is less for the heavier varieties.

Various fire tests have been made before fire-prevention and insurance organizations to prove that this material will make wooden construction almost fireproof. In one test of a building 8 ft. square and 8 ft. high, in which an open fire was built on the floor, giving an inside temperature between 1,600 and 2,040 deg. F. for four hours, the outside of the building was not charred or damaged in any way.

Although a wet gypsum product may be poured into buildings as usually constructed, it is preferable to design them for the use of this material, to provide for complete filling of all sections and especially under wall plates and around windows and doors. By the observance of suitable details, the cost of placing can be greatly reduced. The powder should be stirred rapidly with the water and poured immediately, so that the greater part of the expansion will take place after the material is deposited, and this is particularly necessary when it is poured from a height. Whatever the method of pouring, the pulp should not be deposited more than 3 ft. deep. It should then be allowed to set before a further layer is added; otherwise the cellular structure will be broken down. Only enough water should be added to give full expansion, but the mixture must be sufficiently fluid to prevent bridging in narrow spaces. Pouring can be done in very cold weather, and has been done at 20 deg., F. below zero, by heating the mixing water to about 75 deg. This heat, with the heat generated by chemical action, will protect the material from freezing until it has had time to set. When heat is afterward available in the building, the insulating mass gradually thaws and dries out. However, it is not advisable to use it in very cold weather when this can be avoided, as the cost of placing is greater, and more heat is required in the drying process.

One of the most important factors to be kept in mind in developing the use of adequate thick insulation is that such construction must, of necessity, have no confined air spaces on the cold side of the insulation; otherwise condensation of moisture in the air space will occur. This fact has already been demonstrated in several jobs to which our attention has been directed, and is well known to all who have made a study of cold-storage work. As an instance of this, an expensive residence was constructed in a Canadian city, with a thick layer of granular insulation filler under a slightly sloping roof, but with an air space left between it and the felt and gravel roof covering. Water coming through the ceiling below the insulation damaged the decoration, and as it was thought to be due to a leaky roof, this was torn up and repaired several times without reducing the seepage. An architect accustomed to insulated construction was finally called in, and advised that the moisture in the air between the insulation and the roof was condensing on the under side of the roof covering when this was cold enough to drop the temperature of the inclosed air below the dew point.

This moisture, dropping down, found its way through the insulation and so through the ceiling. On investigation, the insulation filler was found to be water-soaked. The condition was cured by filling up the space above the insulation, and preventing air from entering under the roof.

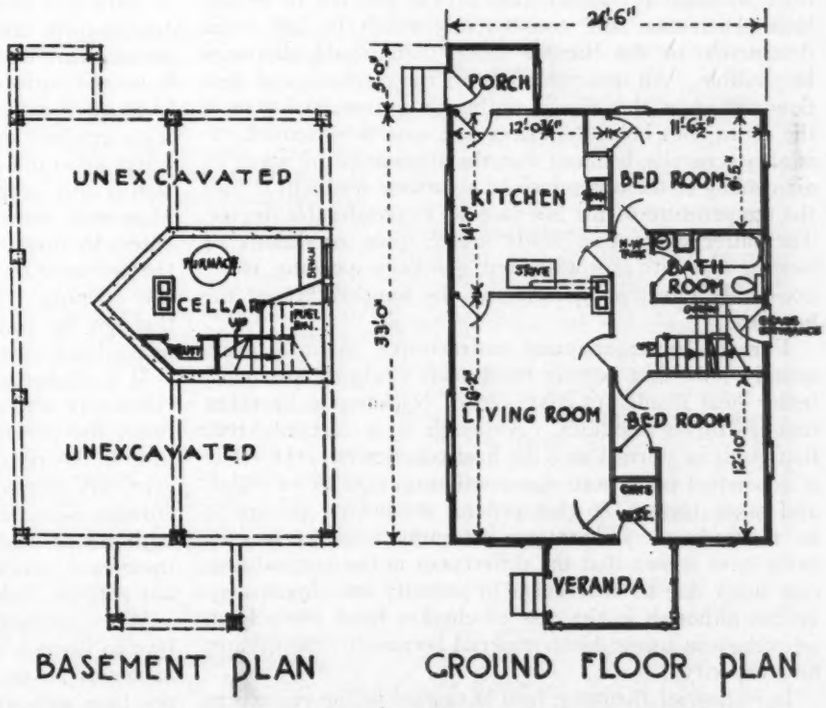


FIG. 1—FLOOR PLANS OF 6-ROOM COTTAGE ARRANGED WITH BASEMENT

[1]The particular product used in the buildings discussed in this paper was known as Insulex, and has been introduced in Canada by Canada Gypsum & Alabastine, Ltd.

With properly designed details, insulation poured in a fluid state, and making a good bond with other materials, will fill every crevice and make the building almost air-tight. If air spaces cannot be avoided, they should be on the warm side of the insulation, or they should be well ventilated to the outside. The difficulties of maintaining a current of air through such spaces are so great that it can almost safely be prophesied that insulated construction for heated buildings will follow the practice now general in cold-storage construction — the entire avoidance of air spaces in either walls or roofs.

The only serious disadvantage to the use of wet-poured insulation is the time necessary to dry it before the building can be used or decorated. All contained excess moisture must be evaporated through the walls, and the time required to effect this depends on both the temperature and the moisture content of the air in the interior rooms, as the outside covering should be waterproof. Spruce or other absorbent paper should be used on the inside of the walls between the studs and the wall covering, to take up the first of the moisture and prevent too heavy soaking of the wall or plaster board where this type of covering is used. If the wall board is placed before pouring the insulation, it should not be heavily sized or waterproofed, because this will retard the drying. If it is necessary to dry quickly, flat-lying chicken wire can be nailed over the absorbent paper, and the wall board put on after the drying out is completed, but this involves added expense for materials and labor. If the moisture content of the air approaches the saturation point, the insulation dries out slowly or not at all, and then artificial heat will assist the drying by raising the temperature and increasing the capacity of the air to take up moisture. Where the moisture content of the air is low, or where the temperature can be raised 50 deg. or more above that of the outside air, the drying is more rapid.

During the drying-out process there must be provision for the removal of the moisture-laden air by windows or other openings, and its replacement with as dry air as possible. To dry out a 3-in. insulated wall takes longer than to dry out a plaster finish, and of course no painting or decorating can be done until the drying is fully completed. However, the advantages gained by using this material are so great that this fault becomes a minor item.

(To be concluded)

Heat Penetration in Refractories

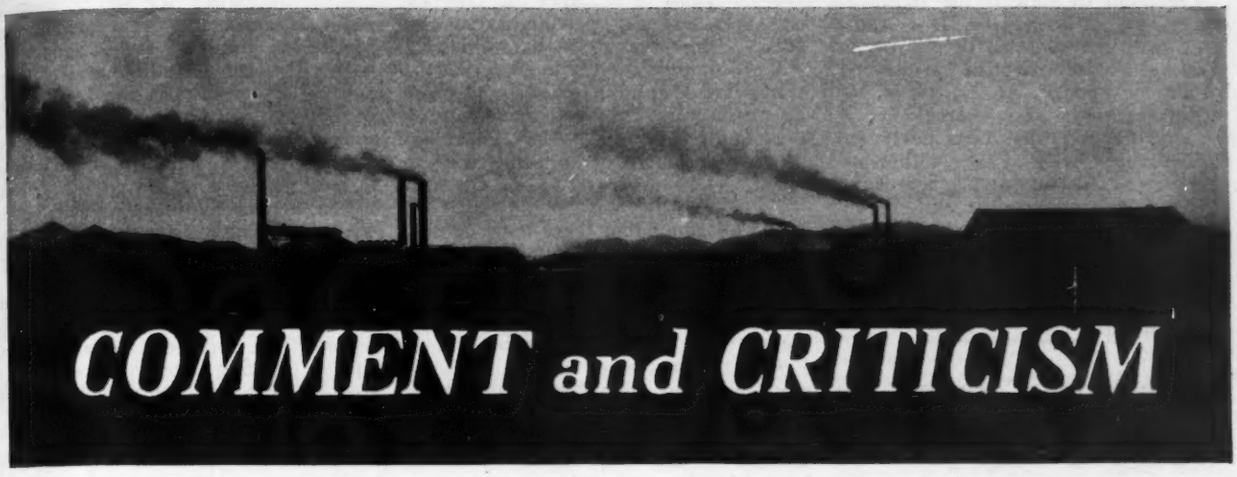
THERE are many popular misconceptions of the manner in which heat penetrates refractory materials and its resultant effect, says M. C. Booze in a technical bulletin issued by the American Refractories Institute. For example, we frequently see colorful advertising matter claiming that the application of a thin wash or coating of a so-called refractory cement will prevent or reduce heat penetration and consequently result in less rapid destruction of the furnace lining than would otherwise be possible. An understanding of the mechanics of heat flow will show that this is ordinarily untrue, and even if the claim does hold, the effect will soon be obscured. It is also generally believed that the application of water or air cooling to the outer face of a furnace wall will reduce the temperature of the hot face by a considerable degree. The latter conception holds under some conditions of heating and with *thin* walls, but, generally speaking, is not noticeably effective in lowering the temperature *at* the hot face.

Furnace operators and refractories manufacturers usually hold that porous hand-made firebrick are much better heat insulators than denser brick made by other manufacturing methods. Although it is certainly true that voids or pores lower the heat conductivity, the effect is dependent upon pore size, continuity, number of pores, and other factors, so that general statements are apt to be misleading. Laboratory determinations on fireclay brick have shown that the differences in commercial fireclay brick due to differences in porosity are almost negligible, although in the case of checker brick there is an advantage in using dense material because of the greater heat capacity.

In industrial furnaces, heat is carried to the refractory walls by *radiation* and by conduction from the gases or air present in the furnace. With other factors constant, the amount of heat radiated from furnace gases varies as the fourth power of temperature, so that radiation in modern high-temperature industrial furnaces is by far the more important factor in transfering heat to the furnace walls. At the face of the wall there is a surface or skin effect which offers some resistance to the inward flow of heat, the amount of resistance being determined by the physical condition of the surface (such as smoothness) and by the nature of the surface material itself. After passing the surface the heat penetrates further into the wall, raising the temperature of the refractory material, and when the latter becomes saturated, passes on and is absorbed either by cooling air or other material in contact with the outer wall face. When the outside of the wall is bare and exposed to the air there will be a decided temperature drop or gradient, ranging from the furnace temperature on the hot face to only a hundred degrees or so on the outside. When insulated, however, the gradient is much less because the heat cannot escape so readily. This gradient approximates a straight line, and the heat effect upon the refractory material in producing vitrification is only noticeable a short distance from the hot face. However, when joints are open or cracks exist the heat enters by direct radiation or gas circulation, and so raises the temperature abnormally in the wall to the depth of the opening. It is because of the temperature drop through the walls that fireclay brick are able to support heavy loads even though the furnace temperature is high.

It is theoretically possible to produce a surface on a refractory wall either by coating or otherwise, which will resist the penetration of heat and produce a noticeable drop in the mean wall temperature. This resistance, however, will depend upon *surface* characteristics. When the furnace is in use for some time, the surface will be coated with ash or slag or altered by vitrification and the effect upon heat penetration will in consequence be almost, if not entirely, lost.

When radiation is the important factor in transfering heat to furnace walls, as it is in most furnaces, cooling by means of air or water boxes reduces the outer face temperature without appreciably affecting the temperature of the hot face. It is true that the heat is taken away from the hot face and delivered to the cooling medium, but the loss is almost made up by additional heat radiated from the gases. Where the walls are thin the heat flow through the refractory to the cooling air or water tubes is more rapid than from the gases to the wall and the temperature of the latter is lowered. It is not to be expected, therefore, that the outside cooling of thick walls will appreciably reduce slag action, since the latter is largely a surface effect.



COMMENT and CRITICISM

Ingenuity and Persistence as Basic Causes of Industrial Insecurity

Suggestions Needed From Engineers Offering Solutions of This Pressing Problem, Which They Have Helped to Create by Making Large-Scale Operations Possible

To the Editor of "E.&M.J.":

Your editorial of Feb. 2, on "Unemployment," is very interesting. It brings up many angles of the recent economic developments. and the status of the engineer in the industrial scheme. The problem is a deep one, and no superficial remedy will solve it. It is ably expressed by Alfred J. Lotka, before the American Association for the Advancement of Science, Jan. 1, 1929, when he said, "Mankind is at the crossroads and either will proceed toward absolute equality among men or toward the establishment of a group of intellectual aristocrats who will rule the world. One fork of the crossroads will lead to a civilization where there will be a vast majority of workers of stunted mental growth; the other leads to 'mass production,' roughly conducted, which should yield us a surplus of leisure. The proper use of collective leisure would be the means of our salvation." Mr. Hoover, in October, 1928, said, "My conception of America is a land where men and women may walk in ordered freedom in the independent conduct of their occupations; where they may enjoy the advantages of wealth, not concentrated into the hands of the few, but spread through the lives of all. . .where a contented and happy people, secure in their liberties, free from poverty and fear, shall have the leisure and the impulse to seek a fuller life." Neither Hoover nor Lotka give us any hint as to how they expect to accomplish these results. Ford, in his recent book, also makes reference to the condition resulting from the new economic movements.

The present industrial problem is primarily due to the engineer and the inventor. They made large-scale operations possible, and perhaps imperative. Notwithstanding the Sherman and Clayton acts, the present tendency, purely as an evolutionary process, is toward larger and larger consolidations. This has been vastly more pronounced since the passage of the anti-trust laws than it was before.

The curious fact is, that whereas the engineer and the inventor are mostly responsible for the present industrial consolidations, they are practically without a channel of expression for its remedy. In all of the engineering organizations and publications, an engineer may discuss the welfare of machines, of mines, and of mills, but he appears to be practically prohibited from discussing the welfare of the engineer and the inventor, except as he may find it through outside efforts in the field of economics or sociology. The engineer, with the inventor, has become a victim of his own sincere striving. He would no doubt be given the privilege of discussing his own welfare along the lines of charity, of bonus, insurance, pension, patronage, and paternalism, but he would quite surely be forbidden to discuss it in the engineering societies on the basis of justice.

If unemployment is such today as to cause alarm, while the large industrial organizations are declaring unusual dividends from unusual profits, and sometimes doubling and even trebling their capital stock, it may reasonably be asked what will be the condition when an economic depression arrives, and when stockholders will be clamoring for dividends while employees are clamoring for jobs?

Within the past year, substantial prizes have been offered for the best suggestions on the Prohibition issue. The industrial problem is immeasurably more important and vastly more urgent than the Prohibition question. Why would it not be a good idea for some one who would not particularly miss a reasonable sum to offer a prize, such as that given on the Prohibition question, for the most fruitful suggestion for the working out of the industrial problem? The sponsor of such a prize would do an immense amount of good by creating interest in the most pressing question in the world; he could also get a lot of fun out of it, as well as some publicity. The prize could be made a free-for-all affair, or, if given by some one interested in engineering and invention, he would probably be interested in limiting it to the engineering profession to see what the engineers and inventors could suggest to get the industrial and social situation out of the mess for which they are primarily responsible.

WILLIAM E. GREENAWALT.

Denver, Colo.

The Great Open Spaces

To the Editor of "E.&M.J.":

The answer to Mr. Wade's lengthy article, "Is Capital Available for Legitimate Prospecting," is brief. The efforts of the company that examined 4,000 submissions is explained by his succinctly stated "and most of us feel that any proposition offered has been turned down by our competitors, probably for good reasons." Probably! And probably not. It might be well to ascertain the reasons. Many times they are, when known, very good reasons and in no way reflecting on the "offering."

The point of view is the significant one. The United States is a rather large order; even some of our rugged Western counties might be "prospected" by the prospector as legitimate and virgin territory. To assert " . . . the entire country has been fairly well combed over" is, on its face, rather preposterous. I recommend a broadening of the view and suggest Mr. Wade's perusal of "Mornin' on the Desert," which follows his contribution.

L. S. ROPES.

Helena, Mont.

Financing a Prospect as a Mine

To the Editor of "E.&M.J.":

Every mine was once a prospect. If there were no mines, we would have no use for mining engineers (except for President of the United States). Naturally, every mining engineer, as well as a lot of people who are not engineers, are interested in the making of new mines. To make a prospect into a producing mine requires some method of financing the preliminary work, and the installation of equipment.

Promoters have been heard to say that "mining requires an aggregation of capital," and many are the plans laid to "aggregate the capital." Stocks, notes, bonds, units, partnerships, royalties, and other interests have been offered for sale in an effort to raise capital. Some have been on the square, some have been successful, some have been incompetently conceived, and some have been willfully nefarious imitations.

Seventy-five years ago anybody could open an office to do a banking business. They called themselves "private banks" and issued banknotes of their own *ad lib*. Many failed. In the State of Michigan a chain of forty-odd banks operated under one company management. The banknotes were engraved with the picture of a "wildcat" or "wolverine" in the center of each note. About 1856 they failed. The newspapers and magazines of that date announced "the *wildcat* currency of the Michigan banks is all worthless." This was the origin of the word "wildcat" as applied to worthless paper.

Today, anybody can promote a mining company, the main requisite being sufficient credit to have the stock certificates printed. When there is no restriction or prerequisite upon those who start a mining corporation, ambitious incompetents and willfully nefarious promoters will rush into the business, even as they rushed into the private banking business before the greenback law gave the government exclusive right to make everything that should pass as money.

This is the condition that faces the mining industry today. It is an open field, filled with organizations and stock companies whose surface indications are no better than were the surface showings of the "private banks" of 1856. Some are good—but which?

I presume that every engineer in the world has been approached many times by prospectors and promoters wanting the engineer to "sell," "buy," "recommend to others," or in some way to "finance" the prospect.

We all admit that there must be new mines—but how? No mine can be developed unless it is financed in some way. Somebody has to do it—but who? Volumes have been written upon the subject; but, after all has been said, I think the prospector and claim owner stand in their own light. Which is the hunted animal? Is the man with the prospect being hunted by the capitalists, or are the capitalists being hunted by the man with a prospect?

My personal observations lead me to believe that the capitalist is the hunted animal. He has been shot at so often, and lured into the open with rotten bait so many times, that he is timid and gun-shy. He has hidden behind glass doors with a body guard of bobbed-headed stenographers barricading the way from the front door to the private office. I haven't noticed any prospectors or promoters hiding from the capitalists.

Yet, notwithstanding all this, there isn't a man on earth with $1 who will not give it up for $2. Capitalists are ever ready to roll a snow ball with their money, but they are not anxious to roll it into the creek.

The burden of proof lies with the vendor to satisfy the purchaser that his goods have some merit—but how? Let us divide the business of mining into four distinct and separate steps:

1. Prospecting — Hunting for the place where nature has made a deposit of metal ores or minerals.

2. Exploring — "Prospecting the prospect," gophering, digging cuts, tunnels, shafts, and otherwise ascertaining the size, depth, extent, dip, strike, and tonnage possibilities.

3. Developing — Opening and equipping for economic production.

4. Mining — Moving the ore, taking it out, shipping, milling.

With these four steps in front of us the capitalist can ask: "Now, Mr. Promoter or Prospector, which one of these four steps do you wish me to finance, and what will you give me for the use of my money to do it? Remember it is the promoter after the capitalist's money, and not the capitalist after the promoter's prospect or his option.

We are confronted with a cold-blooded question: *"Is it possible to outline in advance a plan for making a prospect into a mine?"* It is perfectly possible to outline and plan the second step, after the prospect has been discovered. After that is done, it is possible to outline and plan the third step with even greater detail and accuracy, and after the development is well advanced, and the second step is continuing ahead of the developing, it is possible then to outline and plan the moving of the ores in the fourth step. But, if one attempts to jump over the second and third steps and try to mine the prospect, I think it is impossible to outline anything but a raw failure.

The mistake of the incompetent is in trying to finance a prospect as a mine. Capital will not (and shouldn't) buy a prospect at mine prices, nor equip a prospect as a mine—but there is no difficulty in finding enough money to "explore" a prospect, though it is difficult to find money to develop a prospect that has not previously been explored.

No one can get on the top step of a ladder without climbing step by step over the others. Why should a man expect to jump onto the top step of the mining business without prospecting the prospect, and without developing it; and yet there are thousands of ambitious promoters trying to jump from a piece of waste land, in or near some mining region, to the top step of mining by selling stock.

I'll admit that I know of a thousand prospects that I'd like to see "explored," for which I wouldn't put a dollar into "development" until they have been "explored," and I know of plenty of men who would advance money to explore them if opportunity were given, but the prospector thinks his prospect is already a mine.

He visualizes the prospect with equipment and mill producing daily, and wants pay on what he hopes will be realized some day; but how will it be realized? He never thinks of that. What will he use for money to pay for all this visualized development and equipment? He frequently will not give any one a chance to "prospect the prospect." Naturally, no man is going to explore some one else's ground without some interest or consideration, and that's the problem that faces the financing of a prospect.

LETSON BALLIET.

Tonopah Nev.

Appeals for Capital That Disdain Facts

To the Editor of "E.&M.J.":

I note your editorial in the issue of Dec. 29, concerning the Arriba Gold Fields, Ltd., and their property near El Rito, N. M. Their statement that "the property has not been defiled by the hand of man" is not based on fact, as I investigated this property in 1925, and at that time found several long tunnels driven into the ore, and an old stamp mill which had been used to treat the ore taken from these tunnels. Assays run at the time of my examination gave assay values ranging from a trace to $1.50 in gold per ton.

PHILIP S. HOYT.

Franklin, N. C.

INDUSTRIAL PROGRESS

Selecting the Culvert—An Important Factor in Road Building

CONSTRUCTION and maintenance of roads and highways is a highly necessary part of a mining company's activities in many instances: To cite one case, when a well known company in the Southwest undertook to reopen and equip a certain mine, it found it necessary, as a preliminary to its construction program, to widen the 12-mile wagon road that extended up the valley between the mine and mill so that at all points two cars or teams might pass. This included the catching up and underpinning of seven or eight highway bridges, as well as the provision of the customary means of drainage. In road building, drainage must be given proper attention, if maintenance work is to be kept to a minimum. The amount of money spent on it may be considerable, comparatively speaking, but in most cases this is warranted by results, inasmuch as roadbed and surface depend on successful drainage for their stability, safety and long life. For this reason the selection of a drainage product, such as a culvert or drain pipe, is worthy of careful consideration.

Factors Entering into Cost

The items entering into the cost of any product used in road construction are: Purchase price; transportation from factory to site; cost of installation or assembly complete; maintenance and repairs in service; and depreciation, or cost of retirement. These principles of economics, as applied to drainage structures, such as culverts, culvert bridges and drains, are discussed in a bulletin (H-34) recently issued by the Armco Culverts Manufacturers Association, of Middletown, Ohio.

As for the first item, that of purchase price, it should be borne in mind with respect to drainage products that price alone cannot be relied upon to indicate quality. The prospective purchaser must judge the apparent characteristics of a product in the light of its manufacturer's reputation for quality manufacture, for honesty in making claims, and for consistent adherence to a definite policy. Other than this, the only course is to investigate independently the past service record of the product under consideration. This is direct and certain but will often prove laborious; the former, though indirect, is immediate and dependable.

Freight and haulage charges vary greatly for different types of drains and often constitute large items of cost. Actual freight charges depend directly upon weight and bulk of the product and these characteristics also determine the cost of unloading from cars and hauling to the site. If derricks or other equipment are required in unloading or handling, then the rental of such equipment becomes a necessary part of the cost of transportation. Again, if the product is subject to breakage in transit or in handling, then an allowance for this loss must in addition be made. These costs are always borne by the purchaser.

Flexible Pipe Can Be Nested for Transportation

Flexible and rigid types of pipes differ greatly, not only in the actual weight but also in the number of freight cars or trucks required to haul pipes of the same length and diameter. Flexible pipe has an advantage in that it can be nested, which is an important factor where various sizes of pipe are used on the same job. In addition, the flexible pipe is non-breakable in transit or in handling. These two features reduce to a minimum the cost of transportation to the site—often an item of great importance, as in the case of improvements in mountainous country or at a great distance from railroad or plant.

The cost of installing a culvert or drainage structure begins after all the materials have been delivered to the site and includes all the details required before the structure is ready for service. These details are excavation and the backfill; also formwork, placing headwalls and detours.

With the average drainage structure one of the largest items of installation cost is excavation. The amount of excavation necessary depends on the overall width of the pipe for structure plus the space required for jointing or for formwork. In preparing the bed upon which the drain is to rest, sufficient support must be provided for each section of pipe to assure its retaining its original grade. Pipe of great weight requires a foundation of greater supporting power than does one of lighter weight. Pipe of short sectional length requires a more even foundation than a pipe made in long continuous sections, so that each section will be uniformly supported.

The cost of backfill depends on the amount of material to be moved and on the manner in which it can be handled. Some types of drainage structures require that backfilling be delayed until the structure has acquired its initial strength and that then it be done slowly and with great care so as not to cause severe preliminary stresses. A large load of earth dropped from even a moderate height on a culvert might cause a serious, but buried, fracture. The cost of backfill is directly proportional to the time and care required in its accomplishment.

When using flexible pipe, the cost of excavating and backfilling will be lower because of the smaller outside dimensions of the pipe. Moreover, it is unnecessary to provide much space in the trench for work on joints. Backfill can proceed without delay, as soon as the pipe is in the trench, and by the most convenient method. Although reasonable care should be used, nevertheless the flexible type of culvert is immune to fracture and, after the preliminary covering and tamping, is not seriously injured by loads of earth accidentally dropped directly upon it.

Formwork May Be Needed

Formwork will be required only where structures necessitating concrete retaining walls or similar work are called for. This is always a costly detail of construction work, requiring good material and skilled labor. Usually its cost is not shown separately, but is included in the cost of concrete per cubic yard. If listed separately, however, the principal reason for the high cost of monolithic construction would be apparent.

Placing is the actual erection of the structure in the position where it is to remain throughout its period of service; the assembly of the various units or

Number of Feet in Minimum Carload of 26,000 Lb.

Material	Section Length Feet	Diameter of Pipe in Inches 12	15	18	24	30	36	42	48
Cast Iron	6	312	234	180	108	84	60	48	36
Concrete Pipe	2 or 4	296	216	160	100	72	52	40	28
D. S. Vit. Tile	3	522	372	261	144	90	69	...	...
Spiral Corrugated Cast Iron	3	Not made		399	291	207	174	...	...
Corrugated Ingot Iron	Any length*	2,408	1,984	1,368	760	456	342	228	152

*Length is limited only by type and length of freight car.

parts in right sequence and properly joined; the pouring of concrete in a previously constructed form, including the removal of these forms, and the curing of the concrete during its initial period. It is the most important, and often the most costly, detail in connection with the installation of a culvert or drain.

Where a structure is made up of parts manufactured elsewhere, such as a pipe culvert, the cost of placing will vary directly with the weight and bulk of the unit, with the care required to avoid breakage in handling, and with the time consumed in aligning and joining successive units. Various products differ widely in these respects—a difference which will often more than counterbalance the handicap of a higher purchase price.

Owing to its lighter weight, the flexible type has a great advantage in the lower cost of placing it. The longest section may be handled easily by a small crew and with the simplest equipment. Moreover its sturdy flexible construction permits every move to be made with dispatch and without fear of breakage; its long continuous sections make the pipe self-aligning; and its simple connections reduce to a minimum the time required for mixed joints. Moreover, for a long pipe line joints can be made on the surface before the pipe is lowered into the trench, which also acts to speed up the work and reduce the cost.

Headwalls at the two ends of a culvert are advisable, if not imperative, under certain conditions. They serve to prevent displacement of the culvert or the embankment if either tends to move. Because of the cost, however, the practice is growing of limiting their use to those cases where they are actually needed.

Because of its being continuous from end to end, when placed, flexible pipe cannot be readily separated by embankment pressure. Neither can it be displaced from its original position unless the entire embankment moves. It remains where put until purposely removed and therefore requires no headwalls to anchor it down. By using it the big expense for headwalls, necessary with most culverts, can be avoided.

The Problem of Traffic Interruption

One of the serious problems in connection with construction of highways is that of traffic interruption. Detours must be provided. This is likely to be a matter of small importance in the average mining community, where traffic is rarely dense. However, of two designs of drainage structure, equally acceptable in other respects, the one which in its execution causes the least inconvenience or hazard for traffic is the more advantageous and more economical. The flexible type of pipe permits the most rapid installation, often without any interference of traffic.

Cost of maintenance includes all items required to keep the structure continuously in a safe and suitable condition for the service expected of it. The culvert must be kept clear of obstructions, such as excessive accumulation of sediment or floating objects. Breakage of the culvert caused by its superimposed load must, if possible, be repaired as soon as discovered, lest it progress toward premature failure of the structure. Culvert disalignment resulting from soil pressure or soil movement must be prevented by corrective measures from progressing to such a point that joints are opened, thus weakening the embankment by permitting the material to drop or to be washed into the stream. Excessively open joints which threaten the safety of the roadbed by providing outlets for water percolating through it, from the traveled surface or slopes, must be closed immediately upon discovery, to prevent further honeycombing of the embankment.

Made up, as it is, of long sections of pipe, firmly united into a continuous culvert without open joints, the flexible type avoids practically all the ills common to most culvert structures and the consequent maintenance expense. Sedimentation, which under certain conditions is not entirely avoidable with any type, can be greatly reduced by adoption of a correct grade line.

Depreciation or Cost of Retirement

In addition to the economic advantages accruing to them because of their being of the flexible type, corrugated iron culverts and drains, made of corrosion-resisting iron, have the additional and important advantage of low depreciation due to longer life. Annual cost may be shown to be an easily determinable percentage of the initial cost of the structure. Durability directly affects it. If the initial cost be the same, a structure lasting only ten years may be shown to have an annual cost 58.3 per cent greater than a structure lasting 20 years, 95.6 per cent greater than one lasting 30 years, and 118 per cent greater than one lasting 40 years. A culvert lasting only 20 years will cost each year 23.5 per cent more than one lasting 30 years and 37.5 per cent more than one lasting 40 years. Also, a culvert lasting 30 years will cost each year 11.5 per cent more than one lasting 40 years. In other words, with structures of comparable initial cost, durability is a most potent factor in bringing the cost per year down to a minimum.

Culverts and drains, made of corrosion-resisting metal, such as Armco ingot iron, owe their long life to the durability of the material of which they are made and to their adaptability to the structural requirements of underground construction. The great durability of pure iron has long been a matter of common knowledge.

Conclusion

An analysis of all the factors contributing to the cost of the drainage structure discloses that a drain is not economical just because it is low in first cost. Due to the disparity in weight, bulk and expense of fabrication, the difference in cost for shipping, hauling and installing may easily be great. The short life, moreover, resulting from use of non-durable materials may make the structure the most costly of all practical alternatives. Moreover a high price is not necessarily a guide to economy. First cost may be so high as to be uneconomical with any length of service life, or an immovable or unadaptable structure may be made a total loss by unexpected changes. True economy results from the selection of that type of culvert or drain which is lowest in yearly cost, all things considered. The best materials to meet this test of economy are established by actual service.

Locomotive Cranes Gasoline Driven

A COMPLETE LINE of locomotive cranes designed especially for gasoline-engine, Diesel-engine or electric-motor drive, to be known as the "L" type cranes, has been announced by the Link-Belt Company, Chicago, Ill. These are not merely modified steam cranes, but are designed throughout for the entirely different and much more severe conditions imposed by a power unit running continuously at full operating speed. The machinery and its arrangement are particularly adapted to direct engine or motor drive, and all clutches, brakes, shafts, bearings, and gears are oversize. The drive from engine or motor is totally inclosed and of the silent-chain type. All upper frame gears have teeth machine-cut from solid blanks, making a quiet, smooth-running machine of high efficiency. The crane is furnished with two-speed travel gear.

BULLETINS

Welding Rods—Chicago Steel & Wire Company, 103d St. and Torrence Ave., Chicago. Four pages.

Valves — Rotex Valve Company, Inc., Indiana Ave. and Ella St., Philadelphia. "Nopoket" gate valve. Four pages.

Blowers — Connersville Blower Company, Connersville, Ind. Bulletin No. 121. Victor rotary positive blowers. Four pages.

Motors—Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis. Bulletin No. 158. Small vertical motors. Four pages.

Laboratory Equipment — Ruth Company, Denver. Grinding, mixing, flotation, testing and filtering equipment. Thirty-two pages.

Wiring—Crouse-Hinds Company, Syracuse, N. Y. Bulletin No. 2126. Threadless condulets, couplings and connectors. Eight pages.

Rock Drills—Sullivan Machinery Company, 122 South Michigan Ave., Chicago. Bulletin No. 81-S "Rotator" rock drills. Thirty-two pages.

Welding — General Electric Company, Schenectady. Bulletins Nos. GEA-874C and GEA-876B covering Type WD200A and Type WD-400A arc welding equipment respectively. The same company has also issued Bulletin No. GEA-823B on atomic-hydrogen arc-welding equipment.

A New Indicator for Combustible Gases

A PORTABLE instrument that detects immediately the presence of a wide range of combustible gases or vapors and indicates whether or not the atmosphere containing these gases is safe to breathe and safe for flames or fire will soon be placed upon the market by the Union Carbide Sales Company, 30 East 42d St., New York. The device was first developed by the engineers of the Union Carbide and Carbon Research Laboratories, Inc., as a methane-indicating detector for the detection of methane, or firedamp, in coal mines. The detector has successfully passed the rigid test of the U. S. Bureau of Mines, and has received its approval as permissible equipment for use in methane and air mixtures. In construction the new indicator is identical except for certain modifications to make the instrument better adapted to the detection of numerous combustible gases met in many industrial fields.

The indicator utilizes the effect of combustion of flammable gas and air mixtures on the surface of a heated filament. This combustion increases the temperature, and consequently the electrical resistance, of the filament. This change in resistance causes the needle of a meter to move over a scale, from which the desired information relative to gas conditions is obtained. The indicator comprises the following parts: a detector head or combustion chamber; a meter case; and a portable storage battery.

A cylindrical metal case or bonnet which screws onto a metal base equipped with a short carrying handle forms the head of the detector. The bonnet is provided with louvres or small openings which permit the atmosphere being tested to circulate about the heated filament. Within the bonnet are three concentric gauze screens, of a type similar to those used in flame safety lamps, which prevent the ignition of an external gas and air mixture. In the center of the chamber formed by these screens is the filament cartridge. The detector head is so constructed that accidental incorrect assembly of safety screens and filament cartridge renders the circuit inoperative.

A flexible twin-conductor cable about 50 ft. long connects the detector head with the meter case. The latter contains the various resistances in the detector circuit, the indicating meter, the control switch and a rheostat. A short flexible cable connects the meter case to the portable storage battery which supplies the power to operate the indicator. The storage battery is carried on a leather belt worn around the waist. To this belt are hooked the detector head and the coiled cable. The meter case is carried by a light strap around the operator's neck, or it may be hooked onto the leather battery belt if so desired. The entire outfit is compactly stowed in a carrying case, from which it may be operated without removing the meter and battery from the case if preferred.

By throwing the control switch first to the "Filament" position, then a few seconds later to the "Meter" position, the indicator is made ready for operation. Zero adjustment in fresh air is next made by turning the rheostat knob. The operator then places the detector head in the atmosphere to be tested and reads the meter. The detector head may be held in the hand, raised vertically, or extended horizontally on a pole, or lowered by the cable into a manhole, tank, or elsewhere.

Inserting the gas indicator into a tank

The indicator scale is of a type that will make the instrument equally useful to the average workman or the industrial chemist and safety engineer. For the operator who desires to know the amount in per cent of a known combustible gas present in a mixture of that gas and air, the meter scale reading is taken and then referred to the particular curve or chart prepared for that gas. From the curve chart the operator reads directly the per cent of gas present, corresponding to the scale reading of the meter. Gas charts are plotted with meter scale reading as the horizontal axis and the per cent of gas as the vertical axis.

If an unknown mixture of flammable gases exists, and the operator desires to know whether or not the mixture is explosive, the meter scale reading is taken and referred to a "Per Cent of Explosibility" curve.

Especially for those concerned with gas testing in and about oil tankers, oil and gasoline storage tanks, tank cars, oil refineries, and the like, the scale is also divided into a white section and a red section. If the meter needle comes to rest anywhere in the red section, an atmosphere containing 0.2 per cent or more of combustible gas (expressed as pentane vapor) is indicated, showing that the atmosphere is unsafe to breathe without gas masks and unsafe for any work that requires heat or fire or that is liable to emit sparks. If the meter needle comes to rest in the white section, less than the equivalent of 0.2 per cent of pentane is present, the atmosphere is safe to breathe without gas masks, and hot repair work may be done, provided all other regulations and precautionary measures have been followed.

Some of the important features of the indicator are as follows: Sampling and laboratory analysis are eliminated; indications are immediate; explosive mixtures of gas and air are vividly indicated by continual oscillation of the meter needle; guesswork is eliminated, as readings are direct and accurate; continuous observations may be made while men are working in gaseous atmospheres; all accessible parts of tanks or compartments can be thoroughly tested for gas pockets; the detector head may be lowered into a tank while the operator remains outside; the entire outfit is safe to operate in all gas-air mixtures except those containing acetylene or hydrogen; the apparatus is entirely self-contained and not dependent on any non-portable source of power; and since the platinum filament does not operate catalytically, it is not subject to the deleterious effects of sulphur compounds.

INDUSTRIAL NOTES

The J. E. Knapp Company, of San Francisco, dealing in machinery, has moved to offices in the Balboa Building, 593 Market St., San Francisco.

The Brown Instrument Company, Philadelphia, Pa., announces that O. B. Wilson, has been placed in charge of the company's Cleveland office, at 819 Hippodrome Building.

The American Hoist & Derrick Company, manufacturer of hoisting machinery and crawler-type shovel-cranes, has opened a branch office at 139 Townsend St., San Francisco, Calif. Boyd Nixon has been placed in charge of the San Francisco office.

The C. F. Pease Company, Chicago, manufacturer of blueprint machinery, blueprint paper, photographic arc lamps, and drafting room supplies, has established a new Pacific coast sales office at 501 South Spring St., Los Angeles, under the direction of Ralph S. Gibson, Western sales manager.

The Mine Safety Appliances Company of Pittsburgh, Pa., announces the appointment of Vernon O. Murray as district representative with headquarters at Salt Lake City, Utah. Mr. Murray has had considerable experience in mine rescue work and safety service, having been formerly in charge of the No. 2 Mine Rescue Car of the U. S. Bureau of Mines, stationed at Reno, Nev. The company also announces the appointment of C. N. Schultz as district representative at Buffalo, N. Y., succeeding C. M. Donahue, who has been transferred to the Pittsburgh office as assistant sales manager in charge of gas detecting and recording safety equipment.

Personal Notes

George Fernau has returned to England from Bolivia.

Horace Graham, general manager of Caracoles Tin, in Bolivia, recently visited Salt Lake City.

John F. Neary, attorney for Miami Copper, recently visited the Miami mine, in the Globe-Miami district.

Felix McDonald, mine superintendent, for Inspiration Copper, has returned to Miami after a trip to Cananea, Sonora, Mexico.

Wesley Williams, Canadian mining engineer, is now in the Red Lake district of northern Ontario, examining the Trout Bay and Galena Island properties.

Fred Crothers and **W. A. Smith,** of Anaconda Copper, have been awarded silver First-Aid medallions by the company for meritorious service in first-aid work.

John Wourms has been elected a member of the board of directors of Hercules Mining, operating in the Coeur d'Alene district.

J. O. Elton, manager of International Smelting, has returned to Salt Lake from a trip of inspection to the Walker mine, in Plumas County, Calif.

Charles Adami, general manager of St. Joseph Lead, was recently in Wallace, Idaho, inspecting the mines and mills in the Coeur d'Alene district.

F. G. Pardee and **W. Osgood,** appraisal geologists for the State of Michigan, are in the Michigan copper district, appraising the mining properties.

J. G. Ross, consulting engineer, with the Milton Hersey Company, Ltd., of Montreal, has returned to that city from an examination trip in Arizona and California.

Charles McCrea, Minister of Mines for the Province of Ontario, has returned to Toronto after a trip to the West Indies, where he went to recuperate from illness.

Samuel B. Holbert has been elected president of Dickens Consolidated, in the Coeur d'Alene district. Mr. Holbert has been in charge of operations for the last two months.

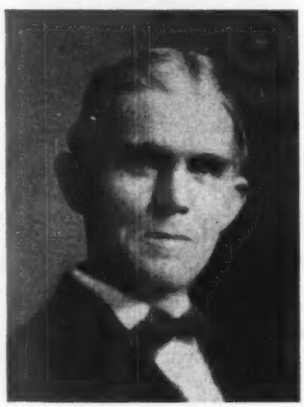
C. M. Nicholson has been appointed mining engineer for American-Canadian Engineering, which controls several properties in the Pend Oreille district, near Metaline Falls, Wash.

G. Carleton Temple returned to London on the "Olympic" on Feb. 23, after a stay of about three weeks in New York City. Mr. Temple will leave London March 14 for La Paz, Bolivia.

Arthur V. Corry, for the last three years resident manager of the Livingston Mines Corporation, near Mackay, Idaho, has resigned. Mr. Corry will resume general mining practice with Harper, MacDonald & Company, of Butte, Mont.

Oscar Howard has been appointed general manager of Tom Reed Gold, operating in the Oatman district of Arizona. Under his direction two new pumps are being installed in the mine to unwater the Aztec workings.

Avery H. Reed, consulting mining engineer, of Marion, Ky., has been awarded the commission of colonel on the staff of the Governor of Kentucky in recognition of his part in the development of the fluorspar industry of the state. He was a graduate of the School of Chemistry of the University of Virginia. Among the mining companies



AVERY REED

with which he has been affiliated are the Hillman Land & Iron Company, Grand Rivers, Ky.; Marion Zinc, of Marion, Ky., as general manager; Longdale Iron, Longdale, Va., as superintendent of mines; Rosiclare Lead & Fluorspar, Rosiclare, Ill., as general superintendent, and the Eagle Fluorspar, Zinc & Spar, Klondike Fluorspar, and Independent Fluorspar companies as consulting engineer. Mr. Reed designed the Rosiclare Fluorspar plant. At present his activities are largely confined to consulting engineering.

Norman C. Stines, mining engineer of the firm of Dutcher, Stines & Company, of Vancouver, B. C., and **Grant Jackson,** banker, of Nome, Alaska, are in New York City in connection with the financing of mining properties.

O. P. Riker, mining engineer, of Long Beach, Calif., has been appointed consulting engineer to Western Mines & Metals, a company that is undertaking development of the Pasadena group of claims, in the Kingman district, Arizona.

E. V. Neelands, general manager of Nipissing Mining; **W. Lee Heidenreich,** field manager of the company; and **James Crowe,** mining engineer, of The Pas, Manitoba, recently arrived in Wallace, Idaho, to examine the Jack Waite mine, on which Nipissing has taken an option.

J. W. Thompson, flotation engineer for General Engineering, of New York and Salt Lake City, has gone to Spain, where he will meet J. F. Callow, president of the company, to discuss plans for a new mill for Rio Tinto. This will be the second mill designed and erected by General Engineering at Rio Tinto. Mr. Callow is in London.

Albert Travers, for many years associated with New Goldfields Consolidated in different capacities in various parts of the world, arrived in Australia recently to take charge of operations for Whitworth Finance & Mining, which has acquired several groups of tin mines in northern Queensland. Mr. Travers is a native of New Zealand and was at one time an associate of Herbert Hoover in Western Australia. He will be assisted by **Oliver Reece,** a graduate of Sydney University, who has been engaged in mining in California for several years.

OBITUARY

C. B. Stranahan, mining engineer, died in Paterson, N. J., on Feb. 16. He was 70 years old and was formerly president of the Davis Sulphur Ore Company. Recently he had been engaged in importing pyrites from Spain.

J. F. Lawson was killed on Feb. 25 in an automobile accident near Prescott, Ariz., on his way to the Lawson mine, of which he was vice-president. Mr. Lawson was formerly a member of the New York Stock Exchange. **Marvin Skoquist,** mine electrician, who was riding with Mr. Lawson, was injured in the accident.

Lewis G. Doty, active in intermountain mining, died at the age of 69 at his home in Salt Lake, on Feb. 19. Mr. Doty had been ill for nearly a year. He was born at Ashland, Ohio, in 1860 and went to Utah in 1885. At one time, he was superintendent of the Bullion Beck, the Eureka Hill, and other Tintic mines. For several years, he was active in the Ely district, and was also an associate of the late John Q. Packard.

James H. Doran, for many years superintendent of the Cardiff Mining & Milling property in Big Cottonwood canyon, near Alta, Utah, died suddenly at a Salt Lake hospital on Feb. 21 following a week's illness. Mr. Doran was born in Bellenck County, Ireland, on Dec. 25, 1876. He began mining in Park City early in his youth. For twelve years he was superintendent at the Cardiff mine. Just before his death, he had been superintending operations at the Park Bingham mine.

Fred C. Dern, Salt Lake mining man and stock broker, and only brother of Governor George H. Dern of Utah, died from the effects of an apoplectic stroke, Feb. 22. Mr. Dern was born Oct. 1, 1876, in Nebraska, the son of John and Elizabeth Dern. After starting his schooling at Fremont, he attended the University of Utah and the Colorado School of Mines. Later, he went to Mercur, Utah, where as the representative of John Dern, pioneer Utah mining man, he was active in managing the Dern properties. On March 1, 1904, he married Miss June McIntyre. Mr. Dern was a director of several mining companies. He was a member of a number of sportmen's clubs, and a 32d degree Mason.

NEWS OF THE WEEK

Summary

THE total cost of improvements being made at Miami Copper, to bring its daily capacity up to 16,000 tons, will be $2,500,000, F. W. Maclennan, manager of the property in the Globe-Miami district, has announced. Page 373.

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Operations of Dixie Bauxite have added a new bauxite-producing district—the Fourche Mountain region—to Arkansas' list.. The company is now putting down a new shaft, known as Dixie No. 2. Page 375.

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Lake Shore Mines is now handling 1,350 tons of gold ore daily and has assumed the leading position in the Kirkland Lake camp. Possibilities of still further increases in mill capacity are mentioned. Page 374.

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Abana, in the Rouyn district, Quebec, has possibilities, M. W. Summerhayes states in his report on the property, which has recently been the subject of considerable controversy. Mill construction is not recommended. Page 373.

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Two American mining engineers at Guanajuato Reduction & Mines, Guanajuato, Mexico, were killed on Feb. 22 by bandits.. U. S. State Department has requested Mexican government to take immediate action. Page 375.

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The Tri-State district is beginning to respond to the improved prices for lead and zinc concentrates, and several mines that have been shut down for two or three years are being reopened. Page 373.

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The Canario Copper case is now being tried before the Federal court in New York City. Prosecuting attorney expects it will last at least a month. Page 372.

Bureau of Mines Has Had $24,000 for Research in Geophysics in Two Years

Importance of the New Prospecting Methods Made Clear by Turner Before Senate Committee—Mendenhall Discusses Needs of the U. S. Geological Survey

By PAUL WOOTON
Special Washington Correspondent

AN INTERESTING phase of the recent hearing before the Mines and Mining Committee of the Senate dealt with geophysical prospecting. That the government has not taken leadership in this important matter was brought out in the cross-examination of Scott Turner, the Director of the Bureau of Mines, by Senator Oddie, of Nevada, the chairman of the committee. As two or three weeks must elapse before printed copies of this hearing will be available, the following extract is taken from the stenographic report:

Senator Oddie—I have been interested in the Bureau's work in geophysical prospecting. How much money did the Bureau have for this work in 1929?

Director Turner—$13,000.

Senator Oddie—What about previous years?

Mr. Turner—We had $11,105 in 1928, and nothing in any year before that.

Senator Oddie—Then the total money spent by government on this important new art of geophysical prospecting to the end of the present fiscal year will be only $24,105?

Mr. Turner—Yes, sir. That includes all the money that the Federal Government has set aside for this purpose.

Senator Oddie—In your opinion, how much money could the Bureau effectively use annually?

Mr. Turner—We should like to tackle geophysical prospecting as a major problem with funds of the relative magnitude of $25,000 to $50,000 per year, continuing for a three- to five-year program.

Senator Oddie—How many regular employees can the Bureau maintain working on this problem?

Mr. Turner—One.

Senator Oddie—Then how has the Bureau accomplished so much with such small personnel?

Mr. Turner—By temporary field employment of others during the summer months, and by co-operation with other organizations without expense to the Bureau.

Senator Oddie—If you were given $50,000 a year for each of five years, how would you spend it?

Mr. Turner—We have thus far only been able to experiment in a small way with electrical methods, principally those of applied potentials.

Senator Oddie—Are there other electrical methods you would like to investigate?

Mr. Turner—We would like to work with electro-magnetic methods, induction methods, and natural-potential methods.

Senator Oddie—Have you done anything with seismic or gravitational methods?

Mr. Turner—Very little. We should like to plan an extensive group of field experiments with these methods.

Senator Oddie—Where are they particularly applicable?

Mr. Turner—They have been used principally in the Southwest in connection with oil and gas pools and salt domes, but we believe a broader application is possible, including stratified orebodies.

Senator Oddie—Has anyone, in government or in industry, gone extensively into the fundamentals of all these methods?

Mr. Turner—Certain inventors, manufacturers, and operators have undoubtedly gone into fundamentals of the methods in which they were most interested, but no general survey of fundamentals has been made. We would particularly like to begin studies in the determination of resistivity to electrical and seismic waves in various mineral formations.

Senator Oddie—Is any allowance made for work done by geophysical methods as to assessment work or patent work on mining claims?

Mr. Turner—Yes, sir. None in this country, but allowances for such work are made in Canada.

Senator Oddie—Does this question properly come before the Bureau of Mines?

Mr. Turner—No, sir. It is a question that should be dealt with by the Department of the Interior.

Senator Oddie—Are new orebodies being found by geophysical methods?

Mr. Turner—Yes.

Senator Oddie—Do you consider that increased use of these methods is to be expected?

Mr. Turner—Yes, sir.

Senator Oddie—To what depth will geophysical methods, as at present applied, reach?

Mr. Turner—Roughly speaking, 800 to 1,000 ft. with electrical methods, and perhaps up to 3,000 ft. with seismic methods.

Senator Oddie—You really think then that these geophysical methods will be, and have already been, of direct and definite aid to operators in the discovery of ore?

Mr. Turner—Without doubt.

Senator Oddie—Are mining men and exploration companies becoming increasingly interested in this subject?

Mr. Turner—Yes, sir. The last three

years have shown great increase in interest. These methods are now commonly employed by various great exploration and operating companies. We know of one oil company that had 16 parties out at one time; at least 75 entirely new oil structures have been discovered in the past two years by seismic and gravitational methods alone. Important new orebodies have been discovered, mainly by electrical methods. There is a big field for application, as yet untouched.

Senator Oddie—Are these methods sufficient in themselves, or are they merely aids to prospecting.

Mr. Turner—They should be considered aids to prospecting and the geophysicist should work with the geologist and with the mining engineer in order that results may be properly interpreted.

"Modern geological research is one of the needs of the mining industry," W. C. Mendenhall, the chief geologist of the U. S. Geological Survey, told the committee. "That research should be extended. High-grade geological maps should be made of many areas. There should be extensive research into the whole possible mineral resources of the United States. That research should be made available to government publications, as far as that is possible.

"In Nevada, for instance, immense amounts of minerals heretofore produced have declined far below the maximum reached in the last century. It rose again and then declined again. There probably are other mineral deposits, but they will be more difficult to find than the earlier ones that outcropped on the surface. To find them geologists and mining engineers must co-operate and use all their knowledge that bears on the problem. That situation is typical of other mining states."

At this point in Mr. Mendenhall's testimony Senator Oddie asked: "Do you think the Geological Survey is receiving the support from the government that it should?" To this Mr. Mendenhall replied:

"We can be very much more useful if we have more liberal appropriations. We constantly are faced with the necessity to decline work we know should be done because of the lack of men and of money." This prompted Senator Oddie to inquire: "Do you feel, if you had ample funds, that you could increase materially the economic welfare of our country and correspondingly decrease taxes to the benefit of the people generally?" Mr. Mendenhall replied that there is no doubt that would be possible. Senator Oddie added that "the Geological Survey should have support in making available adequate information to the public, to the mining industry and to geologists and engineers. The Bureau does not have such support today. It is handicapped in its efforts to do even the most essential research and investigational work."

H. E. Beuhler, director of the Bureau of Geology and Mines for the State of Missouri, told of the unsatisfactory results of the present policy as it affects the various states. "The trouble with the government," Mr. Beuhler said, "is that it starts a proposition and then quits it, leaving the state out on a limb. We started a co-operative geological survey in one of our counties. The Geological Survey expected to pay half the cost of the work. They contributed for three months and ran out of money and had to stop. It cost the state $5,000 to finish it. As a result of that work, however, a marble industry was established which brings into the state each year more outside money than was expended on the whole survey. With regard to electrical prospecting, the Bureau of Mines should have a sufficient appropriation to secure fundamental data. Here is a new line of research. The government has had five years to go into it and has barely started. The government should pave the way for the attack on these fundamental problems."

Avalanche Isolates Silverton, Colo.

AN avalanche that cut off Silverton, Colo., from the outside world on Feb. 6 had not been entirely removed on Feb. 21, and shipments of ore and concentrate from the silver-lead-zinc mines in the district have been held up. Fresh slides are constantly developing, and the district may be isolated for an indefinite period. Inhabitants of Silverton and Eureka have been forced to go on rations, but it is reported that work in the mines has not been interrupted. Sunnyside Mining & Milling is the principal producer in the district.

Canario Copper Case Now Before the Courts

TRIAL of Herbert C. Locke, John F. Locke, George F. Shurtleff, and others for using the mail with intent to defraud in selling stock of Canario Copper, a company operating in Mexico, has been before the Federal court, in New York City, since Feb. 18, when the jury was selected. The government alleges a loss of $5,000,000 to investors. The case has attracted considerable interest in New York papers because of its connection with several prominent theatrical people, with whom the Locke brothers are alleged to have spent their money.

Most of the testimony presented to date has dealt with the methods employed by the defendants, who were all members of Cameron, Michel & Company, in obtaining the funds. Lowell Wadmond, assistant federal district attorney, is in charge of the prosecution. He expects that the trial will last at least a month before all the testimony has been presented. Several of the employees of the brokerage company who were included in the indictment have obtained severance of charges by testifying for the government.

Consolidated M. & S. Options Caledonia, Near Coast Copper

AN option on a 74 per cent interest of the stock of Caledonia Mines, which has been developing a large group of claims near Port Hardy, on the northeast coast of Vancouver Island and near the Old Sport mine, owned by Coast Copper Company, one of Consolidated's subsidiaries, has been taken by Consolidated Mining & Smelting, of Canada. The terms of the option, which were ratified by Caledonia Mines at a special general meeting on Feb. 9, are that Consolidated will take over the 339,600 shares now in the Caledonia company's treasury at 20c. per share and will buy from the original four vendors of the property 13,334 shares at 30c. per share on the signing of the option, a like number at the same price in six months, and approximately 378,000 more at 30c. during the following 18 months. Assuming that Consolidated exercises its option there will be only 160,000 shares held by the public. The Caledonia company has opened by six open cuts, each 50 ft. in length and approximately 50 ft. apart, a zone of milling-grade zinc-copper ore carrying small amounts of precious metals. The zone also has been opened by a tunnel and drift at a depth of about 80 ft. below the surface. The terms of the agreement call for development work to be started not later than April 1.

New Company Develops Claims Adjoining Park Utah

DEVELOPMENT of its holdings in the eastern section of the Park City district, Utah, has been begun by Park City Utah Mines, a new company headed by G. W. Lambourne, president and manager of Park Utah Consolidated. The company is developing its holdings through the Ontario No. 2 drain tunnel of Park Utah. The principal property is the old Liberty group, adjoining Park Utah ground. A fissure system, parallel to the Park Utah, will be explored.

The new company is capitalized at $1,500,000. Officers and directors, in addition to Mr. Lambourne, who is president, include Lawrence Fox, vice-president; D. C. Murphy, secretary; W. A. Dunn, treasurer; and J. O. Elton, William Wraith, and Charles Lang directors.

Leasers Strike High-Grade Ore in C. & A. Territory

A strike of cuprite ore, assaying 15 per cent copper, has been made by Del Norte Leasing in territory belonging to Calumet & Arizona, in the Bisbee district, Arizona. Del Norte Leasing has been operating the Hoatson shaft of Calumet & Arizona for the last five years and also has been working a lease in Phelps Dodge ground. The strike was made between the 1,200 and 1,300 levels of the Hoatson shaft.

Improvements at Miami Copper Will Cost $2,500,000, Maclennan Announces

IMPROVEMENTS in the concentrator and hoisting plant of Miami Copper, at Miami, Ariz., of which some mention was made in the Feb. 23 issue, will cost about $2,500,000, according to the announcement released by F. W. Maclennan, general manager of the property. Developments at the mine have justified these improvements, which will result in increasing capacity to 16,000 tons daily. The summary of improvements by Mr. Maclennan follows:

"To bring the tonnage production of the property up to a point commensurate with the tonnage in ore reserves it was decided in the spring of 1928 to enlarge the capacity of the production plant from 12,000 to 16,000 tons per day, and to remodel the power plant by substituting modern 400-lb. steam pressure equipment for the old 200-lb. pressure equipment. The principal items which go into this are four 720-hp. boilers equipped with air preheaters and water walls and one motor-generator set of 12,000 kw. capacity with condenser and other accessories. In the mine, development work has been pushed ahead to enable the mine to produce increased tonnage and new equipment in the way of ore cars and locomotives is being added to supply additional haulage facilities.

"The main ore hoist is being speeded up from 1,500 ft. to 2,250 ft. per minute to increase its capacity 50 per cent. This is being achieved by installing a 1,400-hp. motor, a duplicate of the present one, on the opposite side of the hoist gear from the present one, and enlarging the pinions of both to the size necessary to attain the rope speed desired. To furnish power for this new motor, a new motor-generator set is being installed which is a duplicate of the present one, consisting of an 1,100-hp. a.-c. motor, a 24-ton flywheel and a 1,000-kw. generator mounted on the same shaft.

"In the crusher plant two new 7-ft. Symons cone crushers are being installed, together with additional screening and conveying capacity. In the concentrator, grinding capacity will be increase by the addition of six 10 ft. 6 in. by 8 ft. cylindrical mills, equipped with Williamson ends. These will be driven by 300-hp. synchronous motors. The classifying capacity will be increased by the addition of six bowl classifiers with 28-ft. bowls and a rake compartment 20 x 42-ft. There will also be installed, ahead of the primary mills, classifiers to remove the primary slime.

"The flotation department will be completely remodeled and the new installation will consist of six 100-ft. Miami-Dunn flotation cells, capable of treating approximately 3,000 tons per cell per day. Supplementing these primary cells, will be installed six 15-ft. cleaner cells, which, with the concentrate re-treatment plant, already in operation, completes the flotation installation.

"During the summer of 1928, a new tailing disposal system was completed and put into operation. The tailings are thickened in a 325-ft. diameter Dorr thickening tank which yields about 2,000 g.p.m. of clear water reclaimed at this point. From here the tailings are pumped against a head of approximately 50 ft. through an 18-in. wood stave pipe line. Paralleling the 18-in. tailing pipe is an 18-in. return water pipe for the purpose of pumping the water reclaimed in the tailing pond back to the concentrator.

"The total cost of these additional installations will amount in round figures to about $2,500,000. Several of the units which are being installed are exceptionally large size. At least three of them are the largest which have been built to date, namely, the 100-ft. Miami-Dunn flotation cell, the 28-ft. bowl classifier, and the 325-ft. dewatering tank."

Report on Abana Mines Is Generally Favorable

THREE oreshoots have been developed at the Abana mine, in the Rouyn district, according to M. W. Summerhayes, who examined the property following the recent controversy over ore reserves and the appointing of F. M. Connell as a director of the company. These oreshoots contain 104,000 tons of partially developed ore. No. 1 shoot, west of the diabase dike, contains 27,000 tons, averaging 23 per cent zinc, with small quantities of the other metals. No. 2 shoot, also west of the dike, contains 12,400 tons averaging 5.36 per cent copper, 5.97 per cent zinc, and 4 oz. of silver. No. 3 shoot, east of the shaft and the dike, contains 64,700 tons, averaging 15 per cent zinc, less than 1 per cent copper and 4 oz. in silver.

A mill is uncalled for at the present, Mr. Summerhayes believes, as the mine has not been sufficiently developed and the shaft is not large enough. When production is started, a new shaft will probably have to be sunk. The property's success will depend on the size and persistence of the oreshoots to depth, the finding of new orebodies and the copper content of such new ore, and on the marketing and treatment of zinc concentrates. Construction of an electrolytic zinc refinery, as announced by Noranda, in association with British Metal and Nichols, would of course aid in development of the property.

Shareholders will be offered new stock on the basis of one share for each fourteen shares now held. The price will be $2. Any shares not taken up have been underwritten at the same price. With the new issue, the company's entire capital of 3,000,000 shares will be out. Of the $400,000 realized by the new issue, $100,000 has already been borrowed and spent.

Higher Prices Stimulate Work in Tri-State District

HIGHER prices for zinc concentrates are bringing about increased activity in the Tri-State mining district. Several mines, idle for almost two years, are being reopened and others, down for a shorter period, are to be reopened soon.

The Cortez mine of the Cortez-King Brand Mines Company, which had been closed for two years, was opened this week. Considerable ore was developed on the lease three years ago, and the mine was opened, but was closed down after a few weeks of operation because of the fast dwindling ore price. The Homestake mine of Federal Mining & Smelting Company, idle for almost two years, has been sold to Harold Arbuthnot, P. J. Kines and others of Baxter Springs, Kan., who will operate it under the name of the Paul Revere.

Two mines of the Federal, the Muncie and the Jarrett, are being worked for the first time in almost two years. The Muncie has been put in operation. Necessary development work which will take a month or two to finish, has been started at the Jarrett, after which it will be placed in operation, P. W. George, general superintendent has announced.

The Mary Ann mine of the Metals Exploration Company, which was closed last December, will be reopened about March 1, according to R. S. Keith. John Craig and associates have purchased the old Sante Fé mine and have started the mill in operation. The mine has been idle for almost three years.

Calument & Hecla Diamond Drilling in Keweenaw County

AT Calumet & Hecla Consolidated's exploration in the Cliff and Phoenix mines, Keweenaw County, Mich., diamond drilling now is proceeding in a southerly direction, to tap new formations at a maximum depth of 2,000 ft. above the Calumet conglomerate. In addition, some drifting on fissure veins will be done in Cliff No. 4 shaft. Later, one or two amygdaloid beds exposed in the shaft may be opened. In spite of the fact that Cliff and Phoenix are old mines, the work now being done is disclosing new formations. Most of the lodes well known in the district seem to be missing. Practically every bed is foreign so far as identification is concerned, the only familiar one being the Ashbed. The Osceola lode farther east was explored several years ago, while the Kearsarge is too far east to be explored from the present shafts. The Calumet conglomerate in this area is negligible as it is only half an inch thick. Any copper bearing formation now cut will be relatively new. Whatever is found in the cores will determine the program for future work, which may include exploratory operations farther north of Phoenix, possibly taking in Delaware, Central and Arnold.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Lake Shore Mill Increases Put Mine in the Lead at Kirkland Lake

TORONTO, Ont., Feb. 23, 1929.—The Lake Shore mine is now the largest producer in the Kirkland Lake camp, and probably the second largest in Canada. With the installation of a new ball mill, the plant has a potential capacity of 1,350 tons daily. In one day, recently, $25,000 in gold was recovered, which would make yearly production more than $7,500,000, if it could be maintained. Production for 1929 is expected to be at least $6,000,000. Developments underground have indicated that additional mill increases are justified and that the mine is in a position to produce 2,000 tons daily.

No action has yet been taken regarding an increase in capacity to this figure, and nothing may be done for some time, but sentiment in mining circles here is that eventually such an increase will be undertaken. With a daily tonnage of 2,000 production would be at the rate at least $10,000,000 a year, from which a profit of $6,000,000 might be expected, if present costs can be maintained. During February, average recovery was more than $18 a ton, but the grade is not expected to remain this high.

THE Noranda Mines report, which will be issued next month, is expected to show a substantial increase in ore reserves as a result of the outstanding developments effected during the year in the H orebody on the 975 level. Prediction of an increase as large as $50,000,000 in gross value of the ore reserves has been made, However, it should be pointed out that by increasing the price of the stock from $20 to $60 a share, such an increase has been very well discounted in advance. Work on the H orebody continues to yield good results, and other development work is also proceeding favorably.

International Nickel will enlarge its refinery at Port Colborne by providing three additional electrolytic units, at an estimated cost of about $1,500,000, which will increase the capacity of the plant to 7,000,000 lb. of nickel monthly. A contract for the structural steel required in this construction work has been awarded to the Standard Steel Construction, Ltd., of Port Robinson, Ont.

H. E. Harcourt, managing director of Jackson-Manion, who was arrested and charged with fraud in connection with operations at the property in the Patricia district, came up for trial recently but was remanded. His bail was $10,000.

The shaft on the Murray claim of Mining Corporation of Canada, in the Rouyn district, Quebec, has reached a depth of 575 ft. Its objective of 1,000 ft. is expected to be reached about the middle of May. A new hoist has arrived at the property. It will be installed and the headframe will be erected before sinking of the shaft is completed.

Only Twenty Fatal Accidents in Tri-State in 1928

MINES of the Joplin-Miami district suffered only twenty fatal accidents in 1928, half of which were caused from fall of rock, according to a bulletin just issued by the accident prevention department of the Tri-State Zinc and Lead Ore Producers' Association. This was less than half as many fatalities as occurred in the previous year, when there were forty-two.

Shovelers again suffered the most in the fatalities, ten of the fatalities falling under that classification, the same number as in the previous year. Machine men and helpers was the second hardest hit classification, five of the twenty deaths occurring in this classification, as against ten in the previous year.

A table showing the classification of the causes of fatal accidents in the district for a period of six years shows 41.08 per cent of the total being due to fall of rock. Handling powder and detonators ranks second with 11.35 per cent. However, in 1928, there was only one accident under this classification. Adoption of the "shot tube," which protects the detonators when holes are being loaded, accounts for the falling off of fatal accidents in this classification.

Hoisting accidents resulted in 9.19 per cent of the fatalities in the past six years, four lives being lost in the year just closed, which brought the percentage for the longer period up to the present level.

Seventeen companies of the field employ full-time safety engineers, and a table in the report would indicate this branch of the industry is a paying one. Companies producing 61.98 per cent of the zinc and lead production of the field in 1928, employing 55.13 per cent of the miners, had only five, or 25 per cent of the fatal accidents during the year, while companies producing 38.02 per cent of the district's concentrates, not covered by safety departments, employing 44.87 per cent of the district's labor, suffered fifteen fatal accidents, or 75 per cent of the total.

President Approves Bill for Potash Research

President Coolidge on Feb. 20 signed the act of Congress authorizing an appropriation of $150,000 for research work looking to the discovery of improved methods of recovering potash. The authorization is intended to take care of a three-year program to be carried on by the Bureau of Mines and the Bureau of Soils.

Mexico City Letter

BY W. L. VAIL
Special Correspondent

Mexican Officials Attempt to Prevent Questionable Mining Promotions

MEXICO CITY, Feb. 17, 1929.—Mexican federal officials are preparing to put an end to the activities of certain individuals and companies, mostly foreign, who have been offering questionable mining promotions to the public. Postal authorities are also taking steps in this direction. Some years ago, federal officials were forced to take drastic steps to clean up a similar situation. Many of these promotions are offered in the United States, in defiance of "blue sky" laws there, and Mexican officials are desirous of co-operating with American authorities on this question.

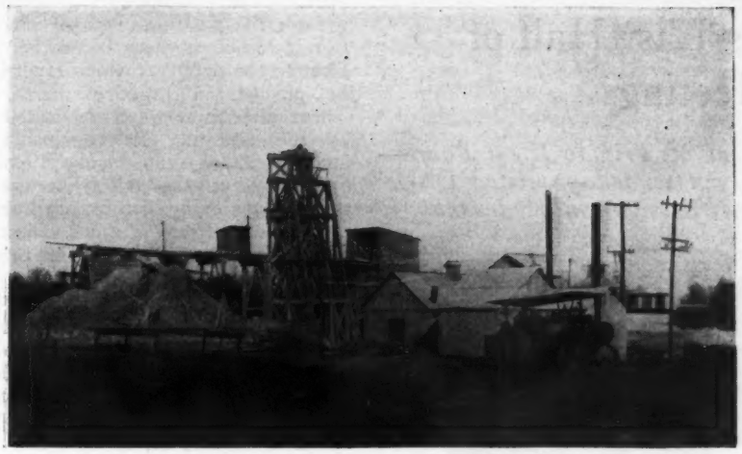
A convention of mining men, for the purpose of airing grievances and hearing suggestions for changes in the present mining law, has been decided on by the government. The meeting will be held in this city, probably next month. The mining division of the Department of Commerce, Labor, and Industry is desirous of having the matter thoroughly discussed and, if possible, of convincing the government that reforms are both necessary and entirely practicable.

INTERNATIONAL ORE is completing the construction of a 120-ton concentrator, near Taxco, Guerrero, according to E. F. Salisbury, general manager of the company. The plant will handle zinc ore. Conditions in that part of Guerrero have recently been reported as improving.

An unconfirmed report has been published in the local press that Mazapil Copper has obtained a concession to erect a lead smelter in Concepcion del Oro, State of Zacatecas. This company, backed by British interests, already operates a lead smelter at Saltillo and a copper smelter at Concepcion del Oro. Construction of a new plant would mean the reopening of several small mines in the vicinity not now in operation.

Diamond drilling has started on copper deposits recently optioned by United Verde near Carbo, Sonora. The geophysical survey of the property, undertaken by Physical Exporation, of Madison, Wis., has been completed. The drill holes will be drilled to a depth of only 300 ft.

Preliminary plans for the automobile road from the terminus of the national railroad at Tepehuanes to the mining camp of Guanacevi, a distance of about 90 kilometers, have been presented to the Department of Communications for approval. As soon as they have been accepted, the contractor, Julius Ambrosius, will begin work.



Hockstra plant of Dixie Bauxite, Fourche Mountain district, Ark.

New Bauxite District Enters Production in Pulaski County, Ark.

DEVELOPMENT of bauxite mining at greater depths during the last twelve months has put the Fourche Mountain bauxite district, Pulaski County, Ark., in the producing list, and promises to give it a long productive life. Until recently prospecting and mining operations were only spasmodic. This district lies immediately south of Little Rock, and embraces an area of approximately 16 square miles. It should not be confused with the Bauxite, or Bryant district, in which the American Bauxite Company is operating and which lies about 14 miles south, in Saline County.

Dixie Bauxite is the largest operating company in the Fourche Mountain district. During past years it produced a large tonnage of ore from three mines in its 65-acre tract. The center of operations is on the Sweet Home pike, three miles southeast of Little Rock. Here, ore is being produced from the Wright and Dixon mines, which are strip-pit operations, and the Hockstra mine, which has been developed with a shaft and drifts. Late in December, Dixie Bauxite started a 10x12-ft. shaft on Dixie No. 2 claim. This shaft is in the center of a twenty-acre tract that had previously been prospected by drilling. Ore was encountered in the drill holes about 130 ft. down.

The Wright and Dixon strip-pit mines are about one acre in extent. From 25 to 30 ft. of clay and gravel had to be removed to reach the orebody, which lies in a blanket formation, approximately 15 ft. thick. The Wright mine has produced about 15,000 tons of ore and the Dixon about 60,000.

Although the initial expense at the Hockstra was much greater, operations are now much more economical than at the strip-pit mines. The shaft at this mine is vertical. Ore is encountered at a depth of 60 ft. Underground development consists of a main haulage drift and a series of secondary drifts. Mining is carried on by the retreating caving system, which makes underground timbering unnecessary. The Hockstra orebody is also in blanket formation, approximately 24 ft. thick. Six headings are being operated, from which about 25,000 tons of ore has been extracted. There are now 6,000 ft. of drifts in the mine.

The strip-pit mines have no mill equipment, but the Hockstra plant consists of an American Process dryer, 32 ft. long and 57 in. diameter; a 10x14-in. American jaw crusher; a Sullivan air compressor; Sullivan and Ingersoll-Rand drills of the jackhammer type; and a Union Pump Company's pump. J. M. Olsen, superintendent of mines, has stated that the company has shipped no aluminum ore. Most of the product goes to northern chemical plants, to cities and towns for water-purification purposes, to manufacturers of abrasives, and to oil refineries.

At the Dixie No. 2 mine the same methods will be used in extracting ore as at the Hockstra. Little hard rock is encountered in this company's operations. Drill records at the Dixie mine show from 50 to 70 ft. of clay and gravel, 30 ft. of lignite, and then the orebody, which is approximately 30 ft. thick. The Dixie will be equipped with a mill. Mechanical equipment will include an L. A. Christie Company dryer, 40 ft. long and 42 in. diameter; a 10x 14-in. American jaw crusher; a Vulcan calciner, 50 ft. long and 60 in. diameter; an Ingersoll-Rand compressor, "Jackhamers," and augur rotators; a Cameron pump; and an electric double-drum hoist, manufactured by the Roger Iron Works, Joplin, Mo. A narrow-gage railroad will be constructed to connect the mine with the railroad loading switch, about one mile distant. On this spur, a five-ton and a seven-ton Whitcomb gasoline locomotive will be operated.

Weather conditions have hampered sinking at the Dixie No. 2, but ore production is expected to start by March 15.

At the Hockstra mine, the company maintains its own laboratory, where all drill cuttings are analyzed before the holes are shot. By this method it is possible to tell exactly where ore should be pulled to fill orders for any one of the three kinds of ore that are mined. If mixing of grades is necessary to fill certain specifications, the mixing is done as the ore goes into the mill.

Two American Mining Engineers Killed in Mexico

ON FEB. 22, Joseph M. Underwood and Cecil C. Aisthorpe, American mining engineers at the property of Guanajuato Reduction & Mines, in Guanajuato, were killed, either by bandits or in a skirmish. According to information given out by an official of the company, a band of men, of unknown number, kidnapped them from their home in Guanajuato City on Feb. 21 and demanded $7,500 ransom. Augustus McDonald, general manager of the company, was about to deliver this sum to the bandits on the morning of the next day when a skirmish took place between federal troops and the bandits. When the rebels had been dispersed, the bodies of the two engineers were found on the ground, about four miles from Guanajuato City. Both showed several bullet wounds.

Ambassador Dwight W. Morrow received a telegram from Secretary of State Kellogg requesting him to ask the Mexican government for swift action leading to the capture and punishment of the murderers of the two engineers. W. E. Wheaton, auditor of Guanajuato Reduction & Mines, reported the case to the State Department.

Cecil C. Aisthorpe was mill superintendent at Guanajuato Reduction & Mines. His previous experience was mostly gained in Colorado, where he built several mills in the San Juan district. He was a native of Michigan. Joseph M. Underwood was mine superintendent at Guanajuato and was a graduate of Oregon State College. He was a native of California and had been in Mexico only eighteen months.

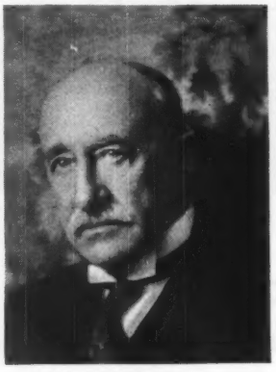
Genii Mining Tunnel Is Within 500 ft. of Goal

GENII MINING, which is driving a 3,200-ft. tunnel to tap the buried Mammoth River channel in the Magalia district, near Oroville, Calif., has just completed drilling through 600 ft. of hard dike rock, and now has about 500 ft. more to go through the softer serpentine before reaching the Tertiary river bed where a high gold content is expected. Drilling is expected to be completed some time in the spring. In drilling through the diorite dike, a 60-ft. mineralized vein of gold and silver was encountered that is thought to have sufficient possibilities to warrant further development after the main object of the enterprise is attained.

Bad Weather Mars Last Half of A.I.M.E. Meeting

Heavy Snowstorm Causes Abandonment of Trip to West Point—Banquet Is Well and Enthusiastically Attended—Spirited Discussion Marks Geophysical Committee Sessions on Wednesday

THE heaviest snowstorm that New York had experienced in three years arrived just in time to spoil the well-laid plans of the A.I.M.E. at its 137th general meeting, which closed in New York City on Feb. 21, one day ahead of schedule. Because of the meteorological conditions, the committee in charge decided to abandon the excursion to the U. S. Military Academy at West Point which had been planned for Feb. 22. However, the weather was unable to get inside the meeting rooms in the Engineering Societies Building or the ballroom at the Waldorf-Astoria Hotel, steam heat being the remarkable invention that it is, and as a consequence the last of the technical sessions and the annual dinner and dance were in no way affected.



JOHN HAYS HAMMOND

The Session on Geophysical Prospecting

Taking as his topic "The Depth at Which Underground Conducting Bodies Can Be Detected by Electrical Methods." A. S. Eve described some field experiments conducted by the Bureau of Mines last summer at Mineville and at Fisher Hill, N. Y., at the session on geophysics on Wednesday. Mining men, he said, were anxious to form some idea of the conditions under which there was reasonable prospect of success when employing electrical methods. At Mineville the problem was that of finding a sheet of magnetite, a good conductor, about 30 ft. thick, the distribution and extent of which had been well determined by diamond drilling. The depth and position of this conductor were not told to the experimenters. Various methods were used and with only one exception no reliable indications were obtained. The exception was that involving the use of the megger. This indicated the presence of a conducting sheet about 700 ft. below the surface, the correct depth. It must not be assumed, however, Dr. Eve cautioned, that orebodies can be detected at this depth under all circumstances. The use of the megger was demonstrated with the aid of a two-dimensional working model.

After this difficult experience over deep-seated ore, a more convenient proving ground was sought and found at Fisher Hill. Here "all the famous methods of the pioneers" readily gave results in good agreement. Methods by others were also tried. A Bureau of Mines paper dealing with these experiments will appear shortly.

In the discussion which followed, Allen H. Rogers, of the Swedish-American Prospecting Corporation, inquired what the purpose of the Bureau of Mines was in doing this work. He could not see, he said, what the Bureau gained by using these patented methods and suggested that they might better study some specific problem, such as the conductivities of rocks. Dr. Eve had said that the Bureau experimenters could not get results with some of the methods and Mr. Rogers wondered if the patent holders could have got them. Dr. F. W. Lee, of the Bureau, responding, said that there was a widespread popular interest in geophysical methods of prospecting and that the Bureau was asked a great many questions about them. It was desirable to delimitate the methods one from the other and to find out if they would do what was claimed for them. They had found that there was an enormous range of reactions. The Bureau had no policy, he said, but was working in a very fruitful field, which they knew would yield results. The chairman, Prof. D. H. McLaughlin, of Harvard, said that Dr. Eve had made the point that it made no difference who did the work; that so long as it resulted in progress it served to widen the scope of the field for all. The time for narrow secrecy was passed, he said.

Following this, a paper by Conrad and Marcel Schlumberger, of Paris, on "Depth of Investigation Attainable by the Potential Methods of Electrical Exploration" was read by Sherwin F. Kelly. Although the term "depth of investigation" in its general sense was understood by everybody, the authors said, it requires precise elaboration as used in geophysics. No geophysical method, irrespective of the physical property studied, can discover a very small body at a very great depth. Aside from this question of the ratio between the size of the body hunted for and its depth, a second factor that plays its rôle in the possible depth of investigation, is the difference, for the parameter under consideration, between the body and the material surrounding it. The greater this difference and the more homogeneous the incasing terrain, the greater the possible depth of investigation. Although there is no theoretical limit to the depth to which studies may be pushed, in practice limits exist. These difficulties were elaborated upon by the authors. In conclusion, the authors stated that during 1928 they had carried out methodical observations, thereby achieving depths of investigation of several tens of miles. The morning session concluded with an informal presentation of recent progress by F. E. Wright, B. B. Gauld and others.

In the afternoon at a public session of the committee on geophysical prospecting, under the chairmanship of Allen H. Rogers, a conference was held as to the possibility of devising methods of recognizing in the mining law the methods and results of geophysical prospecting. Referring to the so-called Douglas bill, now in Congress, which relates to the matter of granting patent without discovery, Mr. Rogers reminded those present that under the present United States mining laws no location could be made without discovery, although he understood that a location would be regarded as valid provided the search for ore was continued without interruption. The Douglas bill did not seem to him to grant the right to construe geophysical prospecting as equivalent to the diligent prosecution of a search for minerals. The Federal law takes no cognizance of geophysical prospecting as a recognized method of prospecting, he said. It should do this and some method should be devised to protect the prospector during the progress of geophysical work. Provision should also be made to permit location of claims larger than can be located at present and to guarantee to the locator possession of them for a period sufficient to enable him to do the necessary work.

The Arentz Bill Discussed

The chairman referred to the report of the Ingalls' Committee on the revision of the United States Mining Law. He read a communication from Mr. Ingalls, in which the latter stated that at the time the so-called Arentz bill calling for revision of the law was introduced in Congress, the development of geophysical prospecting within a decade, such as has taken place, was unforeseen. However, that future discoveries would be deep-lying was foreseen. The bill was avowedly drafted to suit the conditions of big business.

Congressman Arentz, who was present, was asked to comment on the Douglas bill. It does not go far enough along the line that he would like to see, he said. Under it the amount that could be patented, 320 acres, is less than can now be patented. In locating claims, he said, it is customary to locate as much ground as is desired along the line of strike and, in addition to this, a tier of claims above and below the line for protection. Under the old law it is impossible to patent this protective tier unless a discovery were made in place. The Douglas bill would make it possible to get a patent on the protective strip, but this is as far as it goes, he said.

The bill has been misunderstood in the Senate. Before Congress is through with it, it will probably be so modified that it will not be worth anything. Mr. Arentz criticized the bill prepared by the Ingalls' Committee, later given his name (the Arentz bill). He asserted that the committee, in offering it, said that it was perfect and that it should not be changed. To "get away with" this sort of thing in Congress is impossible, he said. Due consideration must be given to politics in the House. The proper course for the Institute to pursue, according to Mr. Arentz, is to "sell" the idea of recodification to the people in the West; the idea that we need recodification; that conditions have changed in the last ten years; that we are now moving on to a more modern way of prospecting for ore. If the Institute is willing to do this, it may be able to obtain results.

Referring to locating soda and potash deposits, conditions are entirely different for these minerals, Mr. Arentz said. The deposits are different. He doubted, moreover, if you can give the man of large means the right to prospect and at the same time keep the little man in the picture. This would be quite satisfactory, if it can be done, but he doesn't see how it can.

Mr. Arentz referred to the Norbeck bill, which, he said, has just been killed in the Public Lands Committee. This bill, he said, would differentiate between the location made on the Forest Reserve and that made on the public domain outside of the Reserve. It proposes that a location made on the Reserve should not carry with it surface rights of any kind. Miners have not injured the Forest Reserve, said Mr. Arentz. For one thing, they could not use the timber on the Reserve for anything but mining.

Here J. O. A. Carper, of Denver, rose to say that there were two Norbeck bills. The first had already passed the house. The Colorado Mine Operators Association is fighting it, because it means an opening wedge in the effort to put everything under the Forest Reserve, which, in his opinion, if successful, would be absolutely murderous to mining. Any recodification of the laws of 1872 should be approached carefully, said Mr. Carper.

James F. Callbreath, Secretary of the American Mining Congress, said that the Federal laws should provide protection for those in the geophysical field, if they do the necessary amount of work and spend the requisite amount of money. Some decision is needed as to how large an area can be located and whether the agencies doing the work should be allowed to proceed to patent after a definite period. The question, said Mr. Callbreath, is what constitutes legitimate prospecting. This the Mining Congress regards as a technical question to be settled by the Institute.

Doctor Mintrop briefly described the procedure required for locating land in Upper Silesia. Sherwin F. Kelly called Doctor Mintrop's attention to the fact that geophysical work on claims is accepted in Ontario and Quebec on a man-day basis. Mr. Leonardon said that formerly, in France, on asking for a concession it was necessary to prove there was "something" in the ground. The French Mining Service had held, he said, that results of geophysical work constituted evidence that there was "something" in the ground and thus paved the way for the granting of a patent. Doctor Mansfield, of the Geological Survey, said that reference has been made to the potash leasing law as something that might be useful in connection with geophysical prospecting. He pointed out that the Geological Survey has to deal with these questions in general before any action can be taken with the Land Office; that is, to decide whether the work was done by competent persons and whether it was adequately done.

One of those present asked if a new law was necessary when a roundabout way of accomplishing the purpose existed. It is not difficult to sink a 10-ft. prospect shaft on some sort of evidence sufficient to hold the ground. He did not intend to imply, he said, that this prospect shaft should be a "fake" but simply that a person would have difficulty in proving that it did not show mineral indications. It would not be an aid in geophysical prospecting but would be sufficient to hold 20 acres for one year during which no adverse rights must be filed. George H. Garrey here remarked that the meeting had been called for the purpose of getting around the various things brought out. Mr. Callbreath said that locations must be preceded by a discovery of ore in place. Hence sinking a shaft would do nothing but hold a discovery that was already valid. The trouble in the West had been, he said, that after a period

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of years during which a group of claims had been held, a court would rule that the evidence was insufficient to justify further work. What is needed, he said, is that, after an area under license has been prospected, the prospector be permitted to pick out a certain spot and search for a discovery in place and have an extension of time to do this. Mr. Callbreath concluded by stating that the government in his opinion should divest itself of all government lands that it does not need for immediate government purposes. Mr. Sundberg described briefly the procedure for locating claims in Sweden.

Here, Mr. Arentz arose to say that he saw no need for talking about not having enough time to do geophysical work. If anyone desires to do such prospecting in any of the public-land states, he has 90 days, after putting up his post, without doing anything further. After digging a hole 128 cu.ft. in size, a further period of two years can be obtained, and this is sufficient for doing any amount of geophysical work desired. Lindley Garrison, of Philadelphia, stated that he thought that Mr. Arentz was quite correct.

The chairman said that apparently Mr. Arentz thought those present were crying wolf. He, himself, however, did not think that a man would be willing to spend money on geophysical work on preliminary work such as described. Mr. Arentz thereupon caused some amusement by presenting an argument for the other side. He said that as he had just described it, the locater who had excavated his 120-cu.ft. hole would have 90 days of grace. Thereupon a second party might come in and, 50 ft. or so away, might find a bit of rock in place, that is, an outcrop, which might assay only 50c. a ton. This, however, would be sufficient to enable him to set up a claim on top of the one already located.

Mr. Garrey said that what Mr. Arentz had stated about there being plenty of time was all very well so far as preliminary location was concerned. Many, however, had already located land and there should be a law to enable them to use geophysical methods in doing their annual assessment work, if they wished to do so.

This concluded the discussion on this topic. The rest of the afternoon was taken up by Doctor C. A. Heiland, of the Colorado School of Mines, who presented an abstract of some of the highly technical papers which had been intended for presentation at the morning session but which had been carried over.

The Banquet

On Wednesday evening, for the last time, the annual banquet was held at the Waldorf-Astoria. Appropriately enough, once the main business of the evening—the food—had been dealt with, Oscar, who made the Waldorf-Astoria what it is, delivered a short address in which he expressed the hope that a new Waldorf would be built and that the A.I.M.E. would not forget old friends, even though in new surroundings.

Shortly after, E. L. DeGolyer, the toastmaster, announced a special feature, which proved to be the reading of two new honor lists, one composed of men who had been members of the Institute for more than 50 years and the other of families, three generations of which had belonged to the Institute. W. S. Ayres, '73, spoke for the former and chided the toastmaster for referring to him and his colleagues as if they were antiques. Mr. Ayres later proved his point by participating in the terpsichorean part of the evening with a thoroughness that put many of his

younger fellow members to shame. Richard Peters, Jr., spoke for the second group, which includes four families—the Douglases, Eilers, Johnsons, and Feltons and Peters.

The awards of the gold medals, a regular feature of the annual banquets, followed. John Hays Hammond, in his acceptance of the William Lawrence Saunders medal, for distinguished work in mining engineering, spoke on "The Engineer." He pointed out that the engineer is essentially an instrument of peace, since his work is of a constructive nature and war is destructive. During the World War, however, the engineer was pressed into service by the warring nations, and his talents were unfortunately turned into paths of slaughter and destruction. His greatest work, however, was in the reconstruction period that followed the war. The return of the belligerents to camparative stability, within a period of ten years since the end of the most destructive war that man has known, is a sign of the competence of the engineer to deal with world-wide problems, and the election of Herbert Hoover to the Presidency of the United States is a recognition of that competence.

Paul D. Merica, who was awarded the Douglas medal for non-ferrous metallurgy, was ill and was unable to attend the banquet, but the award was accepted in his name by Sidney Rolle, chairman of the New York section of the A.I.M.E. Edgar C. Bain, in accepting the Hunt medal for ferrous metallurgy, stressed the importance of cooperation and attributed a great part of the success he had attained in research into the possibilities of stainless and rustless steel, to the aid of others.

The principal address of the evening was then given by Dr. George Otis Smith, the retiring president. He took up at the point that he had closed the year before, by speaking of the distinction between science and engineering. This distinction, he declared, is the fundamental one between theory and practice, "it marks the broad gap between dream and attainment." The man in the street, he pointed out, does not recognize the distinction and frequently gives science more than its due share of popular credit. However, the field of the engineer is tremendous. On this point, he said:

"As I view the new outlook of engineering I cannot subscribe to the century-old definitions which restrict to the resources of nature the application of science by the engineer. . . . The operating engineer cannot escape his human relationships, nor does he wish to. . . .

"A wide field for human engineering lies before us, where the same principles and talents that have given the engineer his mastery over Nature can help him to master human nature. We practical-minded folk must regret that in the half century that has witnessed such extraordinary progress in the physical sciences improvement in social and political affairs has lagged far behind. Even in this enlightened year of 1929 the economies of the steel plant have not penetrated the market place, and the high efficiency of the creators of our electrical equipment is not copied by those who control our city governments. Is not the lesson obvious that engineers are needed in economics and politics?

"A past president of this Institute and the President-elect of the nation has pointed out that there are practically no public questions today that have not engineering implications; in the words of Herbert Hoover, engineers, by being a little more vocal and by acting more collectively, 'could transform the thought of this nation within another twenty years.'"

Dr. Smith then introduced his successor as president of the Institute, Frederick Worthen Bradley, president of Bunker Hill & Sullivan, Treadwell Yukon, and Alaska Juneau. Mr. Bradley asked for a standing vote of thanks for the work done by the Ladies' Auxiliary and then, having voiced his appreciation of the honor accorded him by his fellow members, adjourned the meeting so as to give the orchestra its chance to enliven the proceedings with dance music.

The A.I.M.E. Legion of Honor

ONE of the features ot the A.I.M.E. banquet, on Feb. 20, was the reading of the names of members of a new Legion of Honor, composed of men who had been members of the A.I.M.E. for more than 50 years. The following men were mentioned, together with the year of their admission to the Institute:

Truman H. Aldrich—'78
W. S. Ayres—'73
Andrew A. Blair—'75
Walter M. Brodie—'72
H. M. Chance—'74
Frederick G. Corning—'77
H. S. Drinker—
Founder (*Honorary*)
E. F. Eurich—'74
(*Life Member*)
William E. C. Eustis—'76
Charles W. Goodale—'76
A. Hecksher—'79
Henry D. Hibbard—'79
Julian Kennedy—'79
William St. George Kent—'72
Frank Lyman—'77
John Markle—'79
Samuel Mather—'79
Walter McDermott—'74
Philip N. Moore—'74
Henry S. Munroe—'72
James Wilson Neill—'79
E. E. Olcott—'74
I. P. Pardee—'73
Edward C. Potter—'79
Alexandre Pourcel—'77
(*Honorary*)
William H. Radford—'76
Robert H. Richards—'75
(*Honorary*)
Albert F. Schneider—'74
Porter W. Shimer—'79
John Stevenson, Jr.—'76
Arthur Thacher—'75
Edward H. Williams—'76
Thomas D. Wood—'79

Mining Geology

The paper "Origin of Iron Ores of Iron Mountain and Pilot Knob, Missouri," by Joseph T. Singewald, Jr., and Charles Milton, which was presented by Mr. Singewald at the session on mining geology, on Thursday, brought forth considerable discussion relative not only to the origin of the deposits but also the economic possibilities of the district. Among those contributing to the discussioon were H. A. Buehler, A. M. Bateman, and C. J. Crawford. G. F. Loughlin in discussing "Gold Reserves of the United States" estimated the country's reserve at 110,000,000 oz. under present mining and milling costs, and at 180,000,000 oz. if a reduction in such costs is made that will permit the mining of certain low-grade deposits. Trend of production is expected to continue to decline for several years as the placer mines of California become exhausted, and as the deep mines of that state and others are worked out; subsequently, as the output of Alaska gradually increases, the gold production curve for the country should trend upward. "Relation of Electrode Potentials of Some Elements to Formation of Hypogene Mineral Deposits," by B. S. Butler and W. S. Burbank, was read by Mr. Burbank; "Gold-quartz Veins of the Alleghany District, California," by H. G. Ferguson and R. W. Gannett, was presented by Mr. Ferguson; W. D. Johnston, Jr., discussed "Geological Features of the New Mexico Fluorspar Deposits"; and S. G. Lasky summarized his paper entitled "Transverse Faults at Kennecott and Their Relation to the Main Fault System." "The Extension of Oreshoots With Comments on the Art of Ore Finding," by H. Schmitt, and "The Silver-bearing Minerals of Some Ores From the Tintic Mining District, Utah," by A. W. Hahn, were presented by title only. R. J. Colony presided at the session.

Weather Affecting Output From Kootenay Mines

Unusually severe frosts, prevalent since the beginning of the year, in the Kootenay district, in British Columbia, have caused shortage of water for power and milling purposes at several properties. This has appreciably curtailed production and has resulted in decreased shipments to the Consolidated Mining & Smelting plant at Trail, B. C.

Canadian Institute to Meet in Winnipeg Next Week

MINING men and representatives of allied interests will gather in Winnipeg during March 6, 7 and 8, on the occasion of the thirtieth annual meeting of the Canadian Institute of Mining and Metallurgy, held for the first time in the capital city of Manitoba. This is a tribute to the position Manitoba has assumed in the Canadian mining industry during recent years. An international character will be added to the proceedings by the attendance of scientists from the United States, two of whom will present papers.

Charles Stewart, Canadian Minister of Mines, will attend and reply to the toast of the government of Canada at the annual banquet which will conclude the sessions. He will be accompanied by Dr. Charles Camsell, who will preside at the Institute luncheon held on the opening day.

Well-known Canadians who will attend are J. D. Galloway, provincial mineralogist of British Columbia; Dr. C. V. Corless, formerly manager of Mond Nickel, who will present a paper entitled "The Frood Deposit; A Suggestion as to Its Origin"; Dr. R. C. Wallace, formerly commissioner of mines for Manitoba, and now president of the University of Alberta; and J. E. Hammell, president of Northern Aërial Minerals Exploration, Ltd.

F. W. Bradley, president of the A.I.M.E., has announced his intention to be present. Mineral exhibits from various provinces of Canada will be an important feature of the convention. The Dominion of Canada will be represented by a display which has been assembled under the direction of Dr. W. H. Collins, director of the Geological Survey, and Mr. E. Poitevin, chief of the mineralogical division of the department of mines.

The entire arrangements are in the hands of the Manitoba branch of the Institute, with H. B. Lumsden as convenor of committees. D. V. Reddin is honorary secretary; Dr. J. S. De Lury, commissioner of mines for Manitoba, is in charge of the program details; and entertainment has been entrusted to Col. L. D. M. Baxter, managing secretary of the Manitoba Chamber of Mines. John Bracken, Premier of Manitoba, will extend the province's official welcome to the visitors at the opening session, and D. McLean, mayor of Winnipeg, will act as host at a civic luncheon to be given on the second day of the meeting. The speaker at the annual banquet on the closing day will be D. C. Coleman, vice-president, western lines, Canadian Pacific Railway.

A program of entertainment for the women visitors has been prepared by Mrs. H. B. Lumsden, Honorary Chairman of the Ladies' Committee. It will include afternoon tea at the legislative buildings, where they will be received by Mrs. John Bracken, wife of the Premier, and a luncheon in the Manitoba Club.

Among the speakers who will contribute papers are L. H. Cole, mines branch, Department of the Interior, "The Place of Non-Metallics in the Mining Industry"; J. E. Hammell, "Aërial Exploration"; and L. L. Bolton, assistant deputy minister of mines for Canada, "How the Department of Mines Serves the Public."

Two American scientists will read papers. These are Prof. R. S. McCaffery, professor of metallurgy at the University of Wisconsin, whose paper is entitled "Metallurgical Slags"; and W. H. Emmons, economic geologist of the University of Minnesota. With attention now being directed toward the expansion of the mining industry of Canada, Mr. Emmons' paper, "Ore Deposits of the Canadian Shield," will doubtless attract wide interest, not only in Canada, but also in the United States and abroad.

Developments at No. 1 Shaft of Seneca Are Favorable

SENECA has a good copper showing in the 8 and 9 levels of its No. 1 shaft, in the Michigan copper district. This is in line with results at Mohawk and Ahmeek, adjoining properties, in which the mineral content of the Kearsarge lode has improved with depth. Ahmeek, to the south, has obtained good results all the way down, and its shafts soon will be at a depth of 4,000 ft. No. 2 Seneca shaft, which was clogged with ice, has been cleared, and the skip is in operation. Stripping now will get under way between the 19 and 25 levels, proceeding upward as well as downward.

Stinson Reports on Accidents in Nevada Mines

IN THE 1927-1928 report of A. J. Stinson, state inspector of mines in Nevada, the number of fatal accidents recorded is 22 for the year from Nov. 30, 1927, to Nov. 30, 1928. The approximate number of employees in mines, mills and smelters is given as 6,100. Non-fatal accidents involving ten days or more away from work totaled 451. Fatalities in mines were as follows: Transportation, 2; shaft work, 9; falling down shaft, 1; glory hole, 1; fall of ground, 4; blasting, 2.

International Smelting Adds to Park City Property

International Smelting, Anaconda subsidiary, has increased its holdings in the eastern section of the Park City district, Utah, by acquisition of the Konold group through its holding company, Park Premier. The Konold group is one and a half miles southeast of Keetley, the town at the mouth of the Ontario drain tunnel of Park Utah Consolidated. A compressor will be installed at once, and drifting from the Cummings tunnel will be started to explore a fissure that shows ore on the surface.

Con. Coppermines Extends Two New Haulage Drifts

TWO haulage drifts have been extended 2,000 ft. from the Emma-Nevada shaft of the Consolidated Coppermines Company at Kimberly, Nev., into the porphyry ore zone. The Alpha shaft has been retimbered 1,000 ft. below the surface and pumps have been installed. Three 600-hp. Diesel synchronized engines have been installed for auxiliary power.

A new Nordberg electric hoist, equipped with a 900-hp. Westinghouse motor, has been installed at the Emma-Nevada five-compartment shaft, equipped with two 12-ton skips, counterbalanced and operated either from the surface or underground by an electric push button system. A steel headframe and ore bins have been erected. The machine and steel sharpening shop has been completed, and the new 4,000-cu.ft. compressor put into operation. The drift on the bottom level has been concreted for 900 ft. and underground ore pockets and stations also faced with the same material. The three 600 hp. Diesel engines were made by Busch-Sulzer, and are equipped with Westinghouse electrical parts.

Callahan Zinc-Lead Strikes New Ore on 600 Level

A strike of silver-lead ore has been made on the 600 level of the Callahan Zinc-Lead mine, in the Coeur d'Alene district, according to C. W. Newton, manager of the mine. At a distance of 287 ft. south of the east drift, the crosscut entered the vein, showing 8 ft. of ore averaging 9.5 per cent lead and 8 oz. of silver to the ton. Crosscutting was continued into the south wall of the vein without finding additional ore.

Golconda to Sink New Shaft

Golconda Lead, operating in the Coeur d'Alene district, will probably sink a new three-compartment shaft, according to information disclosed at the annual meeting of the company on Feb. 20. Definite location of the new shaft has not been announced, but it will probably be south of the present shaft, as the Golconda vein dips strongly to the south. In reference to the orebody recently struck on the 1,400 level, W. A. Beaudry, manager of the property, stated that it is 12 ft. wide and of better grade than on the levels above.

Value of Transvaal Production Passes £1,000,000,000

If the premium received during a part of the Great War period be added, the grand total in value, since the beginning of gold mining on the Witwatersrand, now passes the billion pound sterling mark—actually £1,005,194,864 up to the end of December, 1928.

MARKET AND FINANCIAL NEWS

Monthly Dividend Total Continues Upward

THE total of dividend disbursements by American mining companies set a new February record in the month just past. Higher rates of payments by copper companies continue to feature the monthly dividend lists. The February, 1929, list is shorter than that for February, 1928, but the increased payments of the larger companies more than offset the failure of a number of the smaller organizations to maintain their dividends. In fact, the February, 1929, total exceeds by more than $4,000,000 the previous record for the month established in February, 1928.

Increased payments by American Smelting, Anaconda, Miami Copper, United Verde Extension, Cerro de Pasco, and Granby Consol. were important factors in the establishment of the new February dividend record. The following of the smaller companies failed to equal their February, 1928, distributions: Chief Consolidated, Sunshine Mining, Aramayo Mines of Bolivia, Lucky-Tiger Combination, and Wright-Hargreaves. Freeport Texas Sulphur, and Hollinger Consolidated Gold paid smaller dividends than in the corresponding month of last year. One new dividend payer is listed this month, the Idawa Gold Mining Company, operating the Belshazzar mine, in the Boise Basin of Idaho, though this company's initial payment was actually made in December.

The continued improvement in the copper market, as well as further advances in the price of lead and a strengthening of the zinc market, all of which now appear as likely events of the immediate future, will undoubtedly serve to continue the advance in the monthly dividend totals.

E. & M. J. Compilation of Mining Dividends and Yields for February, 1929

Companies in the United States	Situation	Per Share	Total	Per Cent Annual Yield
American Smelting & Refining (New)..	Various	$1.00 Q	$1,829,940	4.6
Anaconda Copper, c, s, l, s.....	Various	1.50 Q	5,378,955	5.3
Bunker Hill & Sullivan, l, s.....	Idaho	0.75 MX	245,250	6.0
Colorado Fuel & Iron, pfd.....	Various	2.00 Q	40,000	....
Freeport Texas, su.....	Texas	1.00 Q	781,235	5.7
Homestake Mining, g.....	S. D.	0.50 M	125,580	10.1
Idawa Gold Mining Co.....	Idaho	0.07 I	56,000	....
Miami Copper.....	Ariz.	0.50 Q	373,558	8.0
National Lead, pfd. "B".....	Various	1.50 Q	375,000	5.3
New Cornelia Copper.....	Ariz.	0.50 Q	900,000	7.0
New Jersey Zinc.....	Various	2.00 Q	981,632	6.2
U. S. Steel, pfd.....	Various	1.75 Q	6,305,497	4.9
United Verde Extension, c.....	Ariz.	0.75 Q	787,500	12.9
Vanadium Corporation.....	Various	0.75 Q	283,775	4.6
Companies in other countries				
Amparo Mining, g, s.....	Jalisco	0.01 Q	20,000	....
Cerro de Pasco, c, s.....	Peru	1.25 Q	1,403,553	6.2
Granby Consol. M. S. & P. c.....	B. C.	1.50 Q	674,997	....
Hollinger Consolidated Gold.....	Ont.	0.05 FW	246,000	7.2
International Nickel of Canada (pfd.)..	Ont.	1.75 Q	155,971	....
Teck-Hughes, g.....	Ont.	0.15 Q	713,574	2.7
Total.....			$21,678,018	

c, copper; s, zinc; l, lead; s, silver; MX, 25c. monthly and 50c. extra; g, gold; n, nickel; su, sulphur; Q, quarterly; I, initial; M, monthly;

Anaconda Organizes New Subsidiary

ANACONDA Copper Mining has formed a subsidiary company known as Anaconda Wire & Cable Company. The new company will acquire the rod and wire mills of Anaconda at Great Falls, Mont., and the wire mills of American Brass Company at Kenosha, Wis. An offering of stock in the new company will be made for the business and assets of Inland Wire & Cable Company, manufacturers of a general line of bare and insulated copper wire and cable, at Sycamore, Ill., upon the basis of one share of stock of the new company for one share of Inland Wire & Cable; in addition stockholders of the Inland company will receive cash dividend of approximately $4.70 a share, representing distribution of Inland's investment account.

Anaconda Wire & Cable will manufacture a general line of bare and insulated copper wire and cable for distribution throughout the country.

Nevada Con. Earnings Show Huge Gain in Fourth Quarter of 1928

NET income of the Nevada Consolidated Copper Company for the fourth quarter of 1928 increased by $1,877,123, or 40 per cent over that reported in the third quarter of 1928. This comes from the company's mines and metallurgical plants in the Ely district, Nevada; Ray district, Arizona, and Chino district, New Mexico.

The net production of copper from all sources for the fourth quarter, compared to that for the three preceding quarters of 1928, is shown in the following tabulation:

1928	Net Pounds Copper Produced	Average Monthly Production
Fourth quarter.....	81,226,417	27,075,473
Third quarter.....	70,951,942	23,650,648
Second quarter.....	63,707,374	21,235,791
First quarter.....	52,576,896	17,525,632

The total quantity of company ores milled and smelted during the quarter was 3,367,386 tons. Of this total 3,331,224 tons was concentrating ore, averaging 1.408 per cent copper, and 36,162 tons was direct smelting ore. In addition to company ores, 190,424 tons of custom ore was milled or smelted at the Nevada plants. The average daily tonnage of company ores milled at all concentrators was 36,209, as compared to 32,279 tons per day for the preceding quarter.

The average recovery in the form of concentrates from all company material milled during the period was 86.35 per cent of the total copper contained therein, corresponding to 24.32 lb. of copper per ton treated, as compared to a recovery of 86.06 per cent and 24.21 lb. per ton for the previous quarter.

The net cost per pound of copper produced, after crediting revenue from gold and silver and other miscellaneous earnings and income from subsidiaries, was 7.58c., as compared with 7.89c. for the third quarter of the year. These costs include all operating and general charges of every kind except depreciation and reserve for Federal taxes.

The financial results of the quarter's operations, as compared with those for the preceding quarters of 1928, are shown below.

	Fourth Quarter	Third Quarter	Second Quarter	First Quarter
Operating profit from copper production.....	$6,015,130	$4,371,515	$3,214,654	$2,180,654
Value of precious metals.....	431,519	389,969	333,233	266,127
Miscellaneous revenues, including income from subsidiaries	496,033	308,471	312,710	251,539
Total operating income.....	$6,942,683	$5,069,956	$3,860,598	$2,698,322
Depreciation.....	415,864	420,260	420,260	420,260
Net income.....	$6,526,819	$4,649,695	$3,440,337	$2,278,061

London Financial News

By W. A. Doman
Special London Correspondent

London, Feb. 12, 1929.—Last week I left the N'Changa Copper Mines negotiations in a very interesting position. On the day following the dispatch of my letter, not only mining circles but the whole City had a great surprise. Following the counter bid for financing the company, made by Rhodesian Anglo-American, the British South Africa Company, the British Metal Corporation, Johannesburg Consolidated Investment Company, Rio Tinto and Union Corporation—a bid thought by some to be in rather forceful terms—a letter of withdrawal was published by the American Smelting & Refining Company. The withdrawal was certainly in very courteous terms, though it seemed to contain a spice of sarcasm in the hope that "Counter offers may in the long run benefit your company's shareholders." At the N'Changa Copper meeting, at which the letter of withdrawal was read, Sir Edmund Davis said he felt convinced that "if some of us had been aware of these negotiations and had been asked to take part in them there would have been no difficulty in arriving at an arrangement satisfactory to the shareholders of this company, the members of the board, and the American Smelting & Refining Company." He regretted that that was not the case because it would have been a great pleasure to see A. S. & R. associated with the English company in the development of part of Northern Rhodesia.

When the original offer was made, certain persons interested in it on the English side were confident it would go through as it "was a moral obligation." There can be little doubt therefore that some were disappointed. But this disappointment was unquestionably from the share market point of view, and had no connection with the ultimate welfare of the company, or of the great copper deposit to which so much attention has been directed. There is, it appears, a little humor in the position, and the cynics say it was a case of Morgans vs. Guggenheims. The Morgans are connected with Rhodesian Anglo-American, and as the Guggenheims have retired in their favor American capital will still be interested in N'Changa.

On previous occasions I have mentioned a report that stocks of tin were being taken off the market in order to stabilize the price. In some quarters this has been denied, but a weekly journal says "it is a fact that quantities of tin are hidden away and not officially reported." That production is increasing is unquestionable—but so is consumption. Prophets in regard to price are at the moment silent. The Tin Selection Trust has some big business on hand, for it is issuing 500,000 new shares at 25s. each.

It now seems fairly certain that some satisfactory arrangement will be made between Russo-Asiatic and the Soviet government. I learn privately that the main points are agreed upon and only minor points remain, but that before the actual agreement is signed the representative of the Soviet will come from Moscow either to London or Paris. When the signature has taken place, technical representatives of Russo-Asiatic and Messrs. Guggenheim will proceed to the Russo-Asiatic properties and make an examination.

International Nickel Directorate Increased to 25

Charles Hayden, chairman of the board of International Nickel Company of Canada, Ltd., recently announced that the board of directors had been increased to 25 from 18, and that Lord Melchett, Sir Harry McGowan, J. P. Bickall, D. Owen Evans, Robert L. Mond, Henry Mond and Grant B. Shipley had been elected as directors. Mr. Hayden also announced that an advisory committee of the board had been constituted, composed of Lord Melchett, Charles Hayden, chairman of the board; Lord Weir, Sir Harry McGowan, J. W. McConnell, James A. Richardson and Robert C. Stanley, president of the company, and that Lord Melchett would be chairman and Lord Weir deputy chairman of the committee.

Ontario's Gold Output Declined in January

The report of the Ontario Department of Mines giving the gold production for January shows that 336,992 tons of ore were treated, the recovery being $2,663,274, an average of $7.93 per ton of ore. This output is a decrease of $300,000 from that of the corresponding month in 1928. The Porcupine mines treated 247,765 tons and recovered $1,604,861, an average of $6.50 per ton. The Kirkland Lake mines treated 89,227 tons and recovered $1,058,013, an average of $11.83 per ton.

Burma Corporation, Ltd., during the month of January mined 41,244 tons of ore, including 4,185 tons of high-grade ore. A total of 30,000 tons of ore was milled, producing 11,100 tons of lead concentrates. A total of 14,518 tons of lead-bearing material, including 3,764 tons of high-grade ore, was smelted, producing 7,166 tons of hard lead. Refinery products were 6,502 tons of refined lead and 592,042 oz. refined silver. Of silver production 36,545 oz. was recovered from the treatment of copper matte. The zinc plant produced 5,050 tons of zinc concentrates, assaying 9.58 oz. silver, 5.45 per cent lead and 51.71 per cent zinc.

In addition to the above 750 tons of copper matte was produced from the treatment of accumulated smelter by-products and 5,721 tons copper ore. A total of 100 tons of refined antimonial lead were also produced. Included in the tonnage of refined lead is 475 tons recovered from smelting copper ore.

C. & A.—New Cornelia Merger Details Are Approved

Gordon R. Campbell, president of the Calumet & Arizona Mining Company, issued a detailed announcement subsequent to a meeting of the directorates of the Calumet & Arizona and the New Cornelia companies recently. At their meetings on Feb. 19 the boards of directors of the two companies approved an agreement to consolidate the two corporations and ordered it executed as required by the Delaware statutes under which they are organized, and submitted to the stockholders of each company at the annual meeting of each corporation with the unanimous recommendation of the boards of directors that the agreement be approved by the stockholders.

The consolidated corporation will be known as Calumet & Arizona Mining Company. It will have an authorized capital of 1,000,000 shares of a par value of $20 per share. Each stockholder in the present Calumet & Arizona Mining will receive one share of the consolidated company stock for each share held in the present company. Each person holding stock of New Cornelia will receive one share of the consolidated company stock for each 2.85 shares of New Cornelia stock held.

The first board of directors of the consolidated company will consist of all the members of the present companies.

When all stock of the present companies is exchanged, the consolidated corporation will have outstanding 842,857 shares and will have in the treasury 157,143 shares for future expansion.

Butte Copper & Zinc Profit Increased in 1928

Report of Butte Copper & Zinc Company for the year ended Dec. 31, 1928, shows profit of $186,158 after expenses and taxes but before depletion, equivalent to 31c. a share earned on 600,000 shares of stock. This compares with profit of $58,309 or 9c. a share in 1927.

Income accounts for 1928 and 1927 compare as follows:

	1928	1927
Ore receipts	$215,375	$87,171
Depreciation	.....	.....
Balance	$215,375	$87,171
Other income	11,119	14,730
Total income	$226,494	$101,901
Expenses, taxes	40,336	43,592
Profit before depletion	$186,158	$58,309

McVittie-Graham Company, which owns 3,000 acres of property scattered along the contact of the Sudbury copper-nickel field, is being taken over by British Metal Corporation, N. A. Timmins, and F. M. Connell. According to reports each of them will take a third interest in a total of $250,000 which will be supplied to carry out a campaign of exploration and development. The total amount will be paid over in cash, which will permit operations to be planned to the best advantage.

The Market Report

Copper and Lead Prices Continue to Advance

New York, Feb. 27, 1929—Unusually turbulent conditions have prevailed in the copper market during the last few days. The entry of several of the largest consumers into the market and their failure to completely satisfy their requirements, even at the advanced quotations, has revealed in some measure the panicky nature of the present situation. The largest producers are sold out further in advance than they feel is desirable, yet the demand for deliveries even further in the future continues. A feature of the recent demand from large fabricators has been the request for a considerable tonnage of prompt, late March, and early April copper. These requests indicate that fabricators find themselves in an underbought position, despite the large purchases made for these positions several months ago. Consequently, the demand from ultimate consumers must be extremely heavy. Several producers are completely sold out for deliveries earlier than June, and as a result were forced to open their books for shipment in that month to meet the demand of the past week. Considerably more than half of the 28,000 tons purchased by domestic consumers during the week ending today has been for June delivery. In one or two instances, a premium is reported to have been offered for near-by positions, but records of such transactions are lacking.

Sales in the foreign market thus far this month are approximately 63,000 long tons, and there is no sign of a let-up in the demand from this market. Copper Exporters, Inc., advanced its c.i.f. price to 18.50c. on Feb. 26, and to 18.75c. today. Sales in the domestic market were at 18½c., Connecticut Valley basis, early this morning, though producers were asking 18¾c. by noon, and late in the afternoon sales at 19c. were reported.

Daily Prices of Metals

Feb.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
21	17.775	49.00	6.95	6.825@6.875	6.35
22	Holiday	.....	....	.....	....
23	17.775	48.875	6.95	6.85	6.35
25	17.975	49.00	6.95	6.875@6.90	6.35
26	18.175	49.00	6.95@7.10	6.875@7.00	6.35
27	18.45	49.00	7.10@7.15	7.00	6.35
	18.030	48.975	7.000	6.905	6.350

Average prices for calendar week ending Feb. 23, 1929, are: Copper, 17.775; Straits tin, 49.075; N. Y. lead, 6.930; St. Louis lead, 6.830; zinc, 6.350; and silver, 55.875.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary form of wire bars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Feb.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
21	77 1/16	77 13/16	84	221 3/4	222 3/4	23 3/8	23 3/8	26 1/8	26 1/4
22	77 1/8	78 1/16	84	220 1/2	221 1/2	23 3/8	23 3/8	26 1/4	26 1/4
25	78 1/16	78 1/8	84	221 1/8	222 1/8	23 1/2	23 1/2	26 5/16	26 5/16
26	79 1/16	80 1/8	85	220 1/2	222	23 9/16	23 5/8	26 5/16	26 1/2
27	81 1/4	82 5/16	86 1/2	220 3/8	222 3/8	23 11/16	23 11/16	26 5/16	26 3/4

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Feb.	Sterling Exchange "Checks"	Silver		Gold London	Feb.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
21	4.84 3/4	55 3/8	25 13/16	84s11 1/2d	25	4.84 3/4	56 1/4	26	84s11 1/2d
22	Holiday	...	25 3/4	84s11 1/2d	26	4.84 3/4	56 3/8	26	84s10 3/4d
23	4.84 3/4	55 7/8	25 13/16	.....	27	4.84 1/4	56 1/4	25 15/16	84s11 1/2d

Average, 56.125

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-eighths cent premium.

Lead Goes to 7.10c.

Following another week of heavy lead sales, prices have been advanced again. This morning the American Smelting & Refining Company raised its New York contract price from 6.95 to 7.10c., reflecting the higher prices that were obtained in outside sales yesterday. Business has been particularly active the last three days, and this afternoon several lots were sold at premiums over the new A. S. & R. price.

Ample lead is available to take care of consumers' wants, according to statistics on stocks, but it is apparently not distributed as well as it might be. Chemical lead seems to be in particular demand, but supplies are largely in the hands of one indifferent seller, and the others are having difficulty in taking care of even regular customers. Nor is desilverized lead freely available in the Middle West. The result is that St. Louis prices are gradually approaching those in New York, and may even attain the Eastern level. Another factor supporting this trend is the possibility of importing bullion lead at the Eastern seaboard, which, it is rumored, has already occurred. That is, one producing company may have paid the duty rather than export lead, as the time limit for the re-exportation of refined bullion expired. This, of course, would help to strengthen the London price, as it takes so much off the foreign market. Domestic prices are so close to London parity that little can be gained or lost by selling imported bullion lead in this market.

Zinc Firm at 6.35c.

Sales of zinc during the past week have been in fair volume, though not sufficient to warrant an advance in price commensurate with the higher concentrate quotation recently placed in effect in the Tri-State district. The situation, statistically, appears somewhat improved, and any concentration of demand in the immediate future is likely to result in higher prices for Prime Western.

Tin Close to 49c.

Tin has shown little variation from the 49c. level all week, the slightly lower price stimulating a little more buying, especially yesterday. Consumption is excellent, but production is more than ample to take care of it, and it remains to be seen if or how long the price can be sustained. The contango in London is increasing, as one might have thought would have occurred months ago, and this condition is reflected in the domestic market, where, in the last day or two, forward tin has been quoted about ten points higher than prompt.

Silver Firmer in Past Week

The silver market has shown some improvement in the last week, advancing from 55⅞c. on Feb. 21 to 56⅜c. on Feb. 26. This advance was apparently caused by heavy purchases of silver for China, as the result of the feeling of unrest throughout China, due to widespread factions working against the Nationalist government. The market closes steady at 56¼c.

Correction: The average silver price for the calendar week ending Dec. 1, 1928, was incorrectly given in the Dec. 8 issue as 57.800c. The correct figure is 57.875c.

Mexican Dollars (Old Mexican pesis): Feb. 21st, 42½c.; 22d, holiday; 23d, 42⅜c.; 25th, 42½c.; 26th, 42⅜c.; 27th, 42½c.

Foreign Exchange

Closing cable quotations on Tuesday, Feb. 26, were as follows: Francs, 3.90$\frac{11}{16}$c.; lire, 5.23⅜c.; and marks, 23.72⅞c. Canadian dollars, $\frac{1}{32}$ per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c.

ANTIMONY—Per lb., duty paid, New York: Chinese brands, 9¼c. per lb. for all positions. Cookson's "C" grade, spot, 14¾c.

BISMUTH—Per lb., New York, in ton lots, $1.70. Smaller lots, $1.85 and up.

CADMIUM — Per lb., New York: 85@95c. Active demand.

IRIDIUM—Per oz., $260@$265 for 98 @99 per cent sponge and powder.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 35c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $38@$40. Small lots bring up to $50. Nominal.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $70. Transactions between dealers and refiners in the outside market are commonly reported at several dollars less.

QUICKSILVER — Per 76-lb. flask, $120@$121 cash. Small lots command the usual premiums.

Prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of Feb. 9.

Metallic Ores

TUNGSTEN ORE—Per unit of WO_3, N. Y.: wolframite, $11.75@$12; Western scheelite, $12.50.

Chrome, Iron, Manganese, Tantalum, Titanium, Vanadium, and Zircon ores are unchanged from quotations in the Feb. 9. issue.

Another Advance in Price of Lead Concentrates

Joplin, Mo., Feb. 23, 1929

Blende		Per Ton
High		$43.65
Premium blende, basis 60 per cent zinc	$41.00@	42.00
Prime Western, basis 60 per cent zinc	40.00@	41.00
Fines and slimes, 60 per cent zinc	36.00@	39.000
Average settling price, all zinc		40.72

Galena		
High		$97.80
Basis 80 per cent lead	$95.00@	97.50
Average settling price, all lead		92.63

Shipments for the week: Blende, 12,785; lead, 3,762 tons. Value, all ores, $869,090.

Shipments two months: Blende, 97,607; lead, 14,640 tons. Value, all ores the two months, $5,186,430.

Buyers report a basis price for lead of only $95, but one seller claims to have sold 2,000 tons on a basis of $97.50. This producer puts in his bins a clean, high-grade concentrate, and leaves it there until the price justifies his decision of its worth.

Buyers closed orders for 13,520 tons of zinc concentrate early this morning, as against a production of 12,140 tons. Stocks are approximately 35,000 tons, including the sales this week and previous sales yet unloaded, as against a stock a year ago of 53,000 tons. Shipments since the first of 1929 have been 3,000 tons larger than the production.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, and Tripoli are unchanged from prices in the Feb. 9 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic) Per lb., 4c. Market firm.

Antimony Oxide, Copper Sulphate, Calcium Molybdate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the Feb. 9 issue.

Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or duty paid, port of entry, $105. Spiegeleisen, 19@21 per cent, $33@$34 f.o.b. furnace.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.04@$1.10,

NICKEL SILVER—Price advanced to 33⅜ from 33¼c. per lb. for 18 per cent Grade A sheets effective Feb. 27.

YELLOW (MUNTZ) METAL—Price for dimension sheets advanced to 24⅛ from 23¾c. per lb.; and for rods to 21⅛ from 20¾c. per lb., both effective Feb. 27.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, and Ferrovanadium are unchanged from prices in the Feb. 9 issue.

Rolled Metals

COPPER—Price for sheets, hot rolled, advanced to 28¼ from 27¾c. per lb.; and for wire to 20⅞ from 20⅜c. per lb., both effective Feb. 27.

LEAD SHEETS—Price of full-rolled sheets advanced to 10¾ from 10½c. per lb.; for clipped sheets advanced to 11 from 10¾c. per lb., effective Feb. 25.

Monel Metal, Nickel, and Zinc Sheets are unchanged from prices in the Feb. 9 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the issue of Feb. 9.

Iron, Steel and Coke

Iron—Per gross ton, Valley furnaces, Bessemer, $18.25; basic, $17.50; No. 2 foundry, $17.50.

Steel—Base prices per gross ton, Pittsburgh, billets and slabs, $33; plates, structural shapes, and soft steel bars, per lb., $1.90@$1.95.

Coke—Per gross ton, Connellsville furnace, $3.00. Connellsville foundry, $3.75@$4.85. Byproduct coke, Ohio and Kentucky, $7; Buffalo and Detroit, $8.50@$9.

Mining Stocks—Week Ending Feb. 23, 1929

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	134⅛	127	133⅛	Mr.29,My.20	Q 1.75
Andes Copper	New York	62½	55	59⅛	No. 15, De. 17	I 0.75
Arizona Com	Boston	4⅛	4	4	Ja. 16, Ja. 31	S.A.0.25
Calumet & Ariz	New York	133½	126½	129	Mr.7, Mr.25	Q 1.50
Calumet & Hecla	Boston	57½	54⅛	56⅛	Fe. 28, Mr. 30	Q 1.00
Cerro de Pasco	New York	109⅛	105	108	Ja. 11, Fe. 1	Q 1.25
Chile Copper	New York	98½	93⅛	97	Mr.22, Ap.22	Q 0.87½
Con. Coppermines	N. Y. Curb	14⅛	13⅛	14		
Copper Range	Boston	27½	26½	27⅛	De. 15, Ja. 15	0.50
East Butte	Boston	4	3⅛	3⅛	Dec., 1919	0.50
Granby Con	New York	91⅛	87½	89⅛	Ja. 4, Fe. 1	Q 1.00
Greene Cananea	New York	177	168	174⅛	De. 1, Ja. 7	Q 1.50
Howe Sound	New York	73	70	7-½	De. 31, Ja. 5	Q 1.00
Hudson Bay	N. Y. Curb	21⅛	20⅛	21⅛		
Inspiration	New York	55⅛	51⅛	54⅛	De. 20, Ja. 7	R 0.75
Isle Royale	Boston	27½	26	27½	Fe. 28, Mr.30	X 0.50
Kennecott	New York	158	154	156½	No. 30, Ja. 2	Q 2.00
Kennecott, new	N. Y. Curb	80	77½	78⅛	Mr.1, Ap.1	Q 1.00
Magma Copper	New York	74⅛	70	72⅛	De. 31, Ja. 15	Q 1.00
Mason Valley	N. Y. Curb	1⅛	1⅛	1⅛		
Miami Copper	New York	41⅛	39½	40⅛	Fe.1, Fe.15	Q 0.50
Mohawk	Boston	45	42	43½	Ja. 26, Mr. 1	Q 1.50
Mother Lode	New York	4⅛	4⅛	4⅛	De.14, De.31	SA 0.20
Nevada Con	New York	50⅛	47	49⅛	De.14, De.31	Q 0.50
New Cornelia	N. Y. Curb	44⅛	42	42½	Fe. 1, Fe. 18	Q 0.50
Noranda	N. Y. Curb	62½	58⅛	62½		
Ohio Copper	N. Y. Curb	3⅛	3	3⅛	Sept., 1926	0.03
Old Dominion	Boston	16⅛	16	16⅛	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	349	306	330	Mr. 15, Ap. 1	Q 2.50
Quincy	Boston	44	42	43	March, 1920	1.00
Roan Antelope	N. Y. Curb	46½	43⅛	44⅛		
St. Mary's M. L.	Boston	40½	38⅛	39⅛	Fe.25, Mr.12	2.00
Seneca Copper	New York	6½	5⅛	6		
Shattuck Denn	N. Y. Curb	24⅛	22½	24⅛		
Sherritt-Gordon	Toronto			8.10		
Tenn. C. & C.	New York	19⅛	18⅛	18⅛	Fe.28, Mr.15	Q 0.25
United Verde Ex	N. Y. Curb	21	17	17⅛	Ja. 4, Fe. 1	Q 0.75
Utah Copper	New York	....	....	285	De. 14, De. 31	Q 3.00
Waite-Ack.-Mont	Toronto			2.35		
Walker Mining	Salt Lake	2.75	2.67½	2.67½		
Wenden Copper	N. Y. Curb	2	1⅞	2		
LEAD, ZINC, SILVER						
Ahumada Lead	New York	4⅛	3⅛	4⅛		
Amer. Z. L. & S.	New York	42⅛	35⅛	39⅛	May, 1917	1.00
A. Z. L. & S., pfd.	New York	103⅛	101	103⅛	Nov., 1920	1.50
Bingham Mines	Boston	51⅛	51⅛	51⅛	De. 20, Ja. 5	Q 0.50
Bunker Hill & S.	N. Y. Curb	140	140	140	Ja. 31, Fe. 5	X 0.75
Butte Cop. & Zn.	New York	8⅛	7⅞	8		
Butte Cop. Con.	Boston Curb	*97	*90	*92		
Butte & Sup.	New York	9⅛	9⅛	9⅛	Dec. 31	Q 0.50
Callahan Zn-Ld.	New York	3⅛	3⅛	3⅛	Dec., 1920	0.50
Chief Consol.	Salt Lake	3.42½	3.35	3.42½	Fe. 1, 1928	K 0.10
Consol. Ld. & Zn. "A"	St. Louis	12	10½	12	Ja. 1	K 0.25
Constitution	Spokane	....	....	*25		
Dayrock	Spokane	....	....	1.85		
Dickens Consol.	Spokane	....	....	*24½		
Eagle-Picher	Cincinnati	20½	19	19⅛	Mr.31, Ap.15	Q 0.20
Eagle-Pich., pfd.	Cincinnati	....	....	102	Jan. 15	Q 1.50
Erupcion	Boston Curb	....	....	*29	Ja. 1, 1928	Q 0.07½
Eureka Bullion	Salt Lake	....	....	*66		
Eureka Lily	Salt Lake	....	....	1.42½		
Eureka Standard	Salt Lake	....	....	4.85		
Evans-Wallower	N. Y. Curb	23⅛	21⅛	22⅛		
Evans-Wal., pfd.	N. Y. Curb	88½	88½	88½	Jan. 15, I	1.75
Federal M. & S.	New York	....	....	300	Je., 1927	10.00
Fed. M. & S., pfd.	New York	....	....	107½	Fe. 21, Mr. 15	Q 1.75
Gladstone	Spokane	....	....	*14		
Golconda	Spokane	....	....	1.50	Mr.20,⅛Ap.1	Q 0.02
Grandview	Spokane	....	....	*69		
Hecla Mining	N. Y. Curb	17	16⅛	17	Fe.15, Mr.15	M 0.15
Highland-Surprise	Spokane	....	....	*14⅜		
Jack Waite	Spokane	....	....	*20⅛		
Kootenay Florence	Spokane	....	....	*21⅛		
Lucky Jim	Spokane	....	....	*18⅛		
Lucky Tiger-C.	Kansas City	†5.50	†5.25	....	De.4, De.20	MX 0.12
Mexican Premier	Spokane	....	....	1.29		
National Lead	New York	148	141	148	Mr. 15, Mr. 31	Q 1.25
Natl. Lead, pfd. A	New York	140	140	140	Mr. 1, Mr. 15	Q 1.75
Natl. Lead, pfd. B	New York	120	118	120	Ap. 19, My 1	Q 1.50
N. J. Zinc	N. Y. Curb	309⅛	302½	306		
N. J. Zinc, new	N. Y. Curb	79	79	79		
New Quincy	Salt Lake	....	....	1.50		
Noble Five	Spokane	....	....	*65		
North Lily	Salt Lake	8.90	8.85	8.90	Jan. 20	Q 0.25
Park Bingham	Salt Lake	....	....	*11		
Park Utah	New York	12⅛	11⅛	12	De. 31, Ja. 2	Q 0.20
Pend Oreille	Spokane	....	....	13.75		
Rico Argentine	Salt Lake	....	....	*48½	No. 30, De. 15	Q 0.03
Ruth-Hope	Spokane	....	....	*51		
St. Joseph Lead	New York	82⅛	70½	78⅛	Ju. 8, Ju.20	QX 0.75
Sherman Lead	Spokane	....	....	*26		
Silver King Coa	Salt Lake	14.00	13.00	13.87½	De. 15, Ja. 2	Q. 0.25
Silversmith	Spokane	....	....	*17	Oct., 1926	Q 0.02
Sunshine Mining	Spokane	....	....	1.48	De. 20,	BM 0.02
Tamarack-Custer	Spokane	....	....	*39½	Sept., 1924	0.25
Tintic Standard	Salt Lake	14.25	14.00	14.12½	De. 23, Ja. 23	X 0.20
Tonopah Belmont	N. Y. Curb			1 1/16	Oct., 1925	0.05
Treadwell-Yukon	Toronto	12.50	11.00	12.50		
United Zinc Smg	N. Y. Curb	1⅛	1⅛	1⅛		
Utah Apex	Boston	5	4⅞	5	Je. 14, Au. 1	K 0.25
Utah Met. & Tun	Boston	1⅛	1⅛	1⅛	Dec., 1917	0.30
Whitewater	Spokane	....	....	1.15		
Yellow Pine	Los Angeles	....	....	*5	Dec., 1925	QX 0.04
GOLD						
Alaska Juneau	New York	7⅛	7⅛	7⅛		
Barry-Hollinger	Toronto	*31	*29	*30		
Central Manitoba	Toronto	*64	*60	*61		
Coniaurum	Toronto	1.90	1.90	1.90		
Cresson Consol.	N. Y. Curb	*98	*95	*95	Jan. 15,	Q 0.02½
Dome Mines	New York	9⅛	9⅛	9⅛	De. 21, Ja. 21	Q 0.25
Golden Cycle	Col. Springs	†1.65	†1.63	....	No. 30, De. 10	Q 0.04
Gold Hill	Toronto	*8⅛	*7	*7⅛		
Hollinger	Toronto	8.70	8.10	8.70	Fe. 8, Fe.25	M 0.05
Homestake	New York	73⅛	72⅛	73⅛	Fe.20, Fe.25	MX 0.50
Kirland Lake	Toronto.	1.46	1.35	1.46		
Lake Shore	Toronto	21.00	20.50	21.00	Mr.1, Mr.15	Q 0.20
McIntyre-Porc	New York	....	....	20⅛	Fe.1, Mr.1	Q 0.25
Portland	Colo. Springs	†*9⅛	†*12	....	April, 1927	0.02
Rand Mines	New York	....	....	36⅛	Fe. 21, '28	Am.Sh.1.52
Siscoe	Toronto	....	....	1.35		
Sylvanite	Toronto	2.15	2.03	2.05		
Teck-Hughes	Toronto	9.10	8.85	9.00	Ja. 31, Fe. 1	Q 0.15
Tom Reed	Los Angeles	....	....	*30	Dec., 1926	0.02
Unity Gold	N. Y. Curb	1⅛	1⅛	1⅛		
Vipond Consol.	Toronto	1.20	1.10	1.14	April, 1927	0.03
Wright-Hargreaves	Toronto	2.28	2.01	2.22	Oc. 16, No. 1	0.02½
Yukon-Alaska	N. Y. Curb	34⅛	34	34⅛		
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	18⅛	17⅛	18⅛		
Castle-Trethewey	Toronto	*39	*36	*38		
Cent. American	N. Y. Curb	....	....	....		
Consol. Cortez	N. Y. Curb	....	....	*25		
Dolores Esperanza	N. Y. Curb	1⅛	1⅛	1⅛	July, 1923	0.05
Keeley	Toronto	*52	*45	*50	Mr.15, 1928	0.04
Mining Corp.	Toronto	5.15	4.90	5.00	De.14,De.31	SA 0.15
Montana-Idaho	Spokane	....	....	*9⅛		
N. Y. & Hond. Ros.	N. Y. Curb	17	17	17	Ja.16, Ja.26	QX 0.50
Nipissing	N. Y. Curb	3⅛	3	3⅛	Mr.30,Ap.20	Q 0.07½
Premier Gold	N. Y. Curb	2	1⅛	1 1/16	De. 14, Ja. 4	Q 0.06
Tonopah Exten	N. Y. Curb	*14	*12	*12	April, 1925	0.05
Tonopah Mining	N. Y. Curb	....	....	3 1/16	Se. 29, Oc. 20	SA 0.07½
United Eastern	N. Y. Curb	*90	*90	*90		
Yukon Gold	N. Y. Curb	*88	*78	*88	June, 1918	0.02
IRON AND STEEL						
Bethlehem Steel	New York	97⅛	87⅛	97⅛	Fe. 15, R	1.00
Beth. Steel, pfd, 7%.	New York	122	121½	121⅛	Mr.4, Ap.1	Q 1.75
Cleveland-Cliffs	Cleveland	140	135	139	Ja.15, Ja.25	QX 2.00
Colo. Fuel & Iron	New York	70⅛	65	70⅛		
Colorado F. & I., pfd.	New York	134⅛	134⅛	134⅛	Fe.11, Fe.25	Q 2.00
Great Northern Iron.	New York	35⅓	33⅛	35⅓	Dec.15, K	2.00
Inland Steel	New York	90	84⅛	88⅛	Fe. 15, Mr. 1	Q 0.87½
Republic I. & S.	New York	87	82⅛	86⅛	Fe. 13, Mr. 1	Q 1.00
Republic I. & S., pfd.	New York	110⅛	110⅛	110⅛	Mr.11, Ap. 1,	Q 1.75
Sloss-Sheffield S. & I.	New York	120	118	120	De. 15,	Q 1.50
Sloss-Sheff. S. & I., pfd.	New York	108	108	108	De.20, Ja.2,	Q 1.75
U. S. Steel	New York	182⅛	169	182	Fe. 28, Mr. 30,	Q 1.75
U. S. Steel, pfd.	New York	142	141⅛	142	.Fe 2, Fe. 27,	Q 1.75
Virginia I. C. & C.	New York	....	....	25	Jan., 1924	1.50
Virginia I.C.& C., pfd.	New York	....	....	48	Jl.16, 1928	SA 2.50
MISCELLANEOUS						
Aluminum Co. of Am.	N. Y. Curb	170	168⅛	170		
Alum.Co.of Amer., pf.	N. Y. Curb	105⅛	105⅛	105⅛	Mr.15, Ap.1,	Q 1.50
American Metal	New York	75⅛	71⅛	72⅛	Fe.9, Mr.1	Q 0.75
Amer. Metal, pfd., 6%	New York	122⅛	118	118	Fe.9, .Mr.1,	Q 1.50
Amer. Sm. & Ref.	New York	11	110⅛	115⅛		
Amer. Sm. & Ref., pfd.	New York	136⅛	136	136	Fe. 1, Mr. 1	Q 1.75
Ang. Ch. Nitrate	N. Y. Curb	40	36	39⅛		
Asbestos Corp.	Montreal	18	16	18	Jan. 1926	1.50
Asbestos Corp., pfd.	Montreal	60	53	54	De. 31, Ja. 15	Q 1.75
Consol. M. & S.	Montreal	510	475	508	De.31,Ja.15,SA	X 6.25
De Beers Consol.	New York	....	....	22	Ja. 19, Ja.26,	0.48
Federated Metals	N. Y. Curb	35	33	34⅛		
Freeport Texas	New York	47⅛	45⅛	46⅛	Ja. 15, Fe. 1	Q 1.00
Int. Nickel Can., new	New York	64⅛	58⅛	64⅛		
Int. Nickel, pfd.	New York	122	122	122	Ja. 18, Fe. 1	Q 1.75
Newmont	N. Y. Curb	190⅛	187⅛	195	De. 28, Ja. 15	Q 1.00
Patiño M. & E.	New York	41⅛	36⅛	39⅛	Aug. 1928	4s.
So. America G. & P.	N. Y. Curb	3	2⅛	2⅛		
Texas Gulf Sulphur	New York	76⅛	72⅛	75	Mr.4, Mr.15	Q 1.00
U. S. Sm. R. & M.	New York	67⅛	64⅛	66	De. 31, Ja. 15	Q 0.87½
U. S. Sm. R. & M., pfd.	New York	55	54⅛	54⅛	De. 31, Ja. 15	Q 0.87½
Vanadium Corp.	New York	110⅛	101⅛	108	Fe.1, Fe. 15	Q 0.75

Toronto Standard Stock Exchange, Toronto, courtesy Arthur E. Moysey & Co.; Salt Lake Stock Exchange, courtesy J. A. Hogle & Co. and Logan & Bryan, New York; Spokane Stock Exchange, courtesy Pohlman Investment Company.

*Cents per share. †Bid or asked. Q, Quarterly. A. Annually. SA, Semi-annually. M, Monthly. BM, Bimonthly. FW, Four weeks. K, Irregular. I, Initial. R, Resumprion. X, Extra. The first data given is that of the closing of the books; the second that of the payment of the dividend.

LONDON QUOTATIONS—WEEK ENDED FEBRUARY 12, 1929

	High	Low	Last	Date	Amount
Alaska Mexican ($5)	12/—	10/—	10/—		
Alaska Treadwell (25)	41/6	40/—	40/—	Nov., 1926	4 (d)
Armayo Mines (25 frs.)	68/1½	65/—	66/3	Feb. 1929	5 (c)
Burma Corp (10 rupees)	18/3	16/9	17/1½	Feb., 1929	7 annas*
Bwana M'Kubwa (5s)	23/6	20/6	22/1½		
Camp Bird (2s)	3/9	3/1½	3/1½	April, 1928	16⅛
El Oro (£1)	5/6	5/3	5/6	Nov., 1924	2½*
Frontino & Bolivia (£)	9/1½	8/10½	9/—	Jan., 1929	3½
International Nickel of Canada (no par value)	$68⅛	$57	$64		
Mexican Corpn. (£1)	12/4½	11/6	12/3		
Mexican Mines of El Oro (£1)	15/—	14/4½	15/—	Dec., 1926	3½*
Mount Isa (£)	43/1½	41/3	41/10½		
N'Changa Copper Mining. (£1)	73/9	65/—	72/6		
Oroville Dredging (4s)	3/—	2/9	3/—	Nov., 1928	31½
Rhodesian Congo Border (£1)	95/7½	81/3	92/6		
St. John del Rey (£1)	12/3	11/3	12/—	Dec., 1928	2½
San Francisco Mines (10s)	35/9	34/1½	35/3	Jan., 1929	25
Santa Gertrudis (£1)	12/6	11/1½	11/6	Jan, 1929	7½
Selukwe (2s. 6d.)	8/3	7/6	7/9	April, 1927	6⅛
S. Amer. Copper (2s.)	3/3	2/10½	3/—	Nov. 1917	75
Tanganyika (£1)	75/—	68/9	70/7½	July, 1928	5
Union Miniere de Haut-Katanga (Brussels)	13,025	12,100	13,000	July, 1928	182.60‡

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian frs. and free of taxation.

(Price quoted in dollars with a fixed rate of $5 to the £1)